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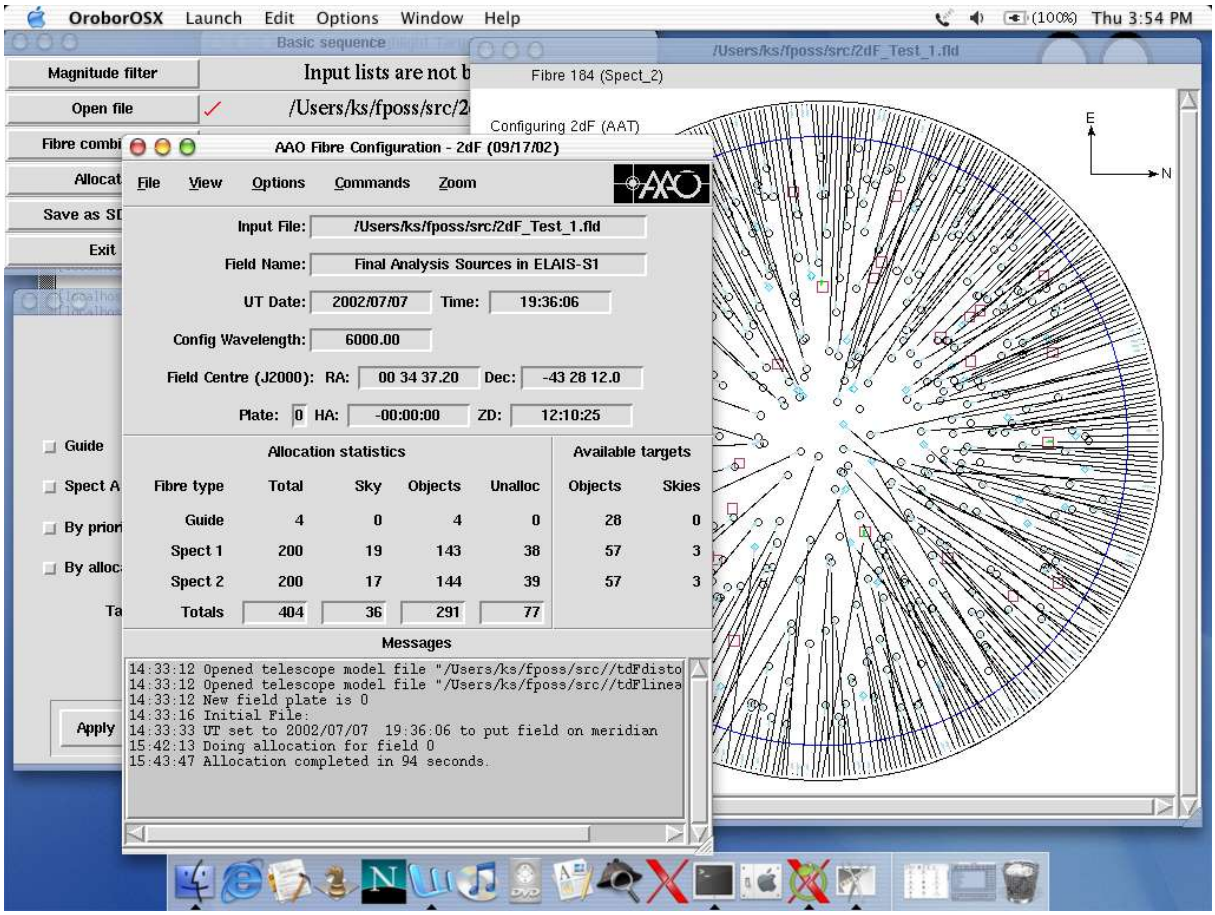
2dF / 6dF / AAOmega CONFIGURE User Manual



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CONFIGURE User Manual

1 Introduction

This manual describes the CONFIGURE Fibre configuration program written at AAO, originally as part of the 2dF project. It takes as input a file containing a list of target objects and generates a configuration in which as many fibres as possible are allocated to targets, allowing for the various instrumental constraints and any specified target priorities. It produces a file containing a list of allocations of fibres to targets. This file needs to be supplied to the instrument software so that it can configure the instrument according to this predetermined configuration. CONFIGURE has been adapted to handle other similar instruments, namely the AAO's 6dF system, ESO's FLAMES instrument, and the AAOmega system that replaces 2dF.

CONFIGURE is available in a separate version that only supports FLAMES. This version is known as FPOSS, and has its own manual, similar to this, but which describes the use of the program in the context of the ESO observation preparation system. The manual you are reading now is designed for people using either 2dF/AAOmega and 6dF, using the version of the program, CONFIGURE, that supports all three instruments. It is unlikely that you will actually want to use this general-purpose version of CONFIGURE to configure FLAMES. If you do, you should be reading the FPOSS manual. This CONFIGURE manual does not attempt to cover the details of FLAMES configurations.

CONFIGURE is run as a standalone program on the observer's own computer system, or at AAO. It is available from AAO in versions suitable for Linux, Solaris, and MacOS X.

This manual begins with a brief summary of how to use the program, aimed at 2dF/6dF/AAOmega observers. This is followed by a detailed formal description of the input text file format. The sections after that present a more formal description of the configuration program.

An appendix contains an introductory tour of the program, taking you in detail through an allocation from the reading of a supplied input text file to the writing of the output SDS file. You may like to run through this when you start to use the program, just to get familiar with the way it works. The appendix provides little that cannot be found in the main body of the manual, apart from a number of illustrations, but some users may find this the most convenient introduction to CONFIGURE.

1.1 Versions and Simulated Annealing

A major recent change to CONFIGURE has been the introduction of a new allocation algorithm based on simulated annealing. This was developed with AAOmega in mind, but works equally well for other instruments, and is now the default version. The CONFIGURE release now contains two executables: the default 'configure' executable, which implements the new simulated annealing algorithm, and 'configureTrad' which has been built around the traditional 'Taylor' and 'Oxford' algorithms. Although this manual has been updated to reflect this change, this updating is still incomplete, and in many places the reader needs to be aware that it is probably the traditional version that is being described.

1.2 Purpose

This document serves as the User Manual of the CONFIGURE fibre configuration software. It has been written for operators of the instrument and astronomers. The reader is assumed to be familiar with whichever of the 2dF/AAomega or 6dF instruments they intend to use.

1.3 Scope

This manual only covers the operation of the CONFIGURE program itself. It does not cover the any of the details of observing with 2dF/AAomega or 6dF. It does not cover use of CONFIGURE for use with the FLAMES instrument in sufficient detail to serve as the manual for FLAMES configurations.

1.4 Abbreviations and Acronyms

The following abbreviations and acronyms are referenced in this document:

2dF	The AAO's 2 degree Field Facility, used at the AAT
6dF	The AAO's 6 degree Field Facility, used at the UKST
AAO	Anglo-Australian Observatory
AAOmega	The AAO's AAOmega facility, which replaces 2dF at the AAT
AAT	Anglo-Australian Telescope
FACB	The ESO term for a guide fibre
FLAIR	The 6dF spectrograph
FLAMES	The ESO VLT Fibre Facility
FP	Fibre Positioner
FPOSS	The version of CONFIGURE specific to FLAMES.
GUI	Graphical User Interface
gzip/gunzip	Standard UNIX file compression/expansion utility programs.
PAF	Standard file format for VLT internal files
SDS	Standard file format for AAO internal files
Tcl	Tool Command Language
Tk	Tcl Windowing Toolkit.
UKST	United Kingdom Schmidt Telescope
VLT	Very Large Telescope

1.5 Nomenclature

Throughout this manual the term 'reference star' is used for a target that is intended to be allocated to the guide fibre bundles. The term 'guide star' is only used for a star intended as a target for the VLT guide probe, something that only concerns observers using the FLAMES instrument, who should not really be using this manual. Earlier versions of this manual, and of the program, used the terms 'reference star', 'guide star' and 'fiducial' more or less interchangeably.

1.6 Figures

As with all UNIX programs, the detailed appearance of windows depends on the window manager being used, so when you run the program it may not look exactly as it does in the screen shots in this document. The screen shots in this document are from a mixture of systems. Some are from the OroborOSX window manager on a MacOS X system. Others are from the PC-Xware NCD window Manager displaying configure running on a Solaris 2.6 system. All the illustrations were made running CONFIGURE in its 2dF mode. In 6dF mode it looks almost identical, except for the number, distribution and size of fibres in the mimic display, and the fact that 6dF only has the one spectrograph, so has only guide fibres and 6dF fibres. The AAOmega version is the same as 2dF, except for some minor differences in the number and location of guide fibres, and the way that the field plates are specified.

2 Overview

The configuration program is part of the observation preparation software used by a number of instruments built by the AAO. These include the original '2dF', the more recent '6dF', the 'OzPoz' fibre positioner built for the 'FLAMES' instrument for ESO, and the ‘AAOmega’ facility that replaces 2dF at the AAT. All of these instruments use a robotic fibre positioner to place optical fibres in the focal plane of the telescope so that light from a number of target objects may be fed to spectrographs or other instruments. These all need a configuration phase in which the fibres are allocated to targets in such a way that the fibre configuration is physically possible (fibres and the 'buttons' that carry them do not collide, and fibres are not bent past their allowed tolerances, for example), and the best coverage possible is achieved (as few unallocated targets as possible, without any strange artifacts in the distribution of allocated targets, for example).

A version of this program is distributed by ESO as an adjunct to the P2PP process for FLAMES, and this version of the program is known as FPOSS (Fibre Positioner Observation Support Software). The version distributed by AAO is capable of configuring any of the three supported instruments, and this version, called CONFIGURE, is the version described in this document.

The role of the configuration program (CONFIGURE) is to take a text file containing a list of target objects and to allocate fibres to these in as optimal a way as possible. It then writes out a file giving the details of the resulting configuration. When 2dF or 6dF is being configured, this file is written out in the AAO’s Structured Data System file format (SDS), and has to be supplied to the observing software when the observation is set up.

The rest of the manual is organised as follows:

- Chapter 3 describes some of the changes made for the current version.
- Chapter 4 summarises the use of CONFIGURE for 2dF/6dF/AAOmega observers.
- Chapter 5 describes some more advanced features of the program.
- Chapter 6 provides information about file formats.
- Chapter 7 provides comprehensive descriptions of program facilities.
- Chapter 8 gives details about obtaining and installing the software.
- Chapter 9 provides menu guides and explanations.

- Chapter 10 describes the additional options available in ‘expert’ mode.
- Chapter 10 is an appendix that provides an illustrated tour of CONFIGURE.

3 Changes from previous versions

This section is designed for users who are familiar with previous versions of CONFIGURE. When CONFIGURE was modified for use in 2002 with the ESO FLAMES system, it was fairly comprehensively overhauled, and as a result users will notice a number of differences between the latest version and earlier versions. There are also a number of differences that may not be immediately obvious, but which are important, nevertheless. (And, of course, any comprehensive overhaul of a piece of software will usually fix many bugs but will also introduce new ones. Please report any you find to cr@aaocbn.aao.gov.au. You should read the brief appendix on bug reporting, section 11, first.) The following sections highlight some of the main changes.

3.1 Systems supported

The new version supports 2dF/AAOmega, 6dF and FLAMES. The initial dialogue box that comes up when the program is first run allows you to select which instrument is to be used. Note that once you select an instrument you cannot change to another instrument other than by exiting the program. In 2005 the number of fibres available for 2dF was changed, and CONFIGURE was modified to support a variant of 2dF called ‘2dF-old-404’ (the 404 refers to the original number of fibres). AAOmega (which is essentially the 2dF system with new AAOmega spectrographs replacing the original spectrographs) is treated as another variant of 2dF. Generally in this document, ‘2dF’ should be taken as meaning to ‘2dF in either its original or AAOmega guise’.

3.2 Fibre types

The way fibre types are handled has been completely revised for the new version. This is vital for FLAMES, which has a number of different fibre types, not all of which can be allocated at the same time. For 2dF/6dF which distinguish only between guide fibres and spectrograph fibres, and (for 2dF) between the two spectrograph fibres, it is less important, but may still be useful. For example, for 2dF you can specify how sky targets are to be distributed between the two spectrographs. This emphasis on fibre types can be seen in a number of the changes listed in this section.

3.3 Basic sequence window

The basic sequence window that attempts to guide you through the steps of a basic configuration is new. It has its origins in the requirements for the ESO FLAMES instrument, which has quite a complex basic configuration sequence including the need to select a VLT guide star. For 2dF and 6dF use it may not be quite so useful, but it does provide a convenient location for some of the common controls needed – such as the ‘Allocate’ button. It also provides a convenient feedback in some cases – it provides the most convenient display of the total number of fibres allocated, for instance. There is nothing available in the basic sequence

window that cannot be found in the menus of the main control panel. If you think it gets in the way, the best thing to do is minimise it and forget about it.

3.4 Allocation statistics

The main control panel now displays allocation statistics separately for each fibre 'type'. For FLAMES, which has a number of different fibre types, this is important. For 2dF, where the fibre types are only 'guide', 'spectrograph 1' and 'spectrograph 2', and for 6dF which only distinguishes between 'guide' and 'spectrograph', this is less important, but it may be useful. It also displays the number of available targets for each fibre type. Note that any unallocated non-guide target within the field can potentially be assigned to either spectrograph, so is included in the total for each fibre type.

Note: with the advent of the simulated annealing algorithm, which handles priority allocations particularly well, the statistics panel has been replaced by a bar graph that shows the priority distribution of allocated objects. It may be that the original numeric display, more suited to systems with multiple fibre types, will be made a selectable option in a later release.

3.5 Target selection panel

This panel appears when the 'Select targets' option in the 'View' menu is selected. It provides a means of highlighting targets that meet various criteria, such as allocated/unallocated, target type, priority, etc. This is shown in Figure 1.

Note: with the advent of the simulated annealing algorithm, the priority selection option in this panel has been deleted; priority highlighting is handled much better by the new allocation statistics panel in the main GUI.

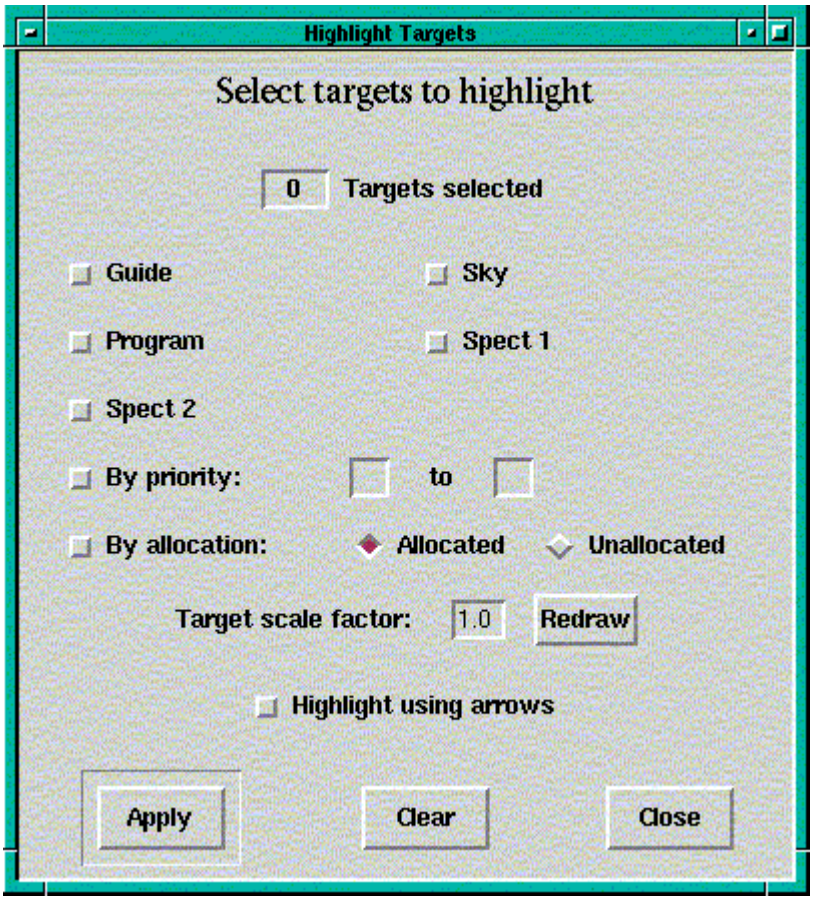

Figure 1 The 'Select targets' panel

The ‘highlight using arrows’ option is useful when there are a large number of targets – it makes the selected objects stand out quite dramatically.

3.6 Fibre type selection

The options menu now has a ‘set fibre combination’ entry which allows you to select one of a number of pre-defined fibre combinations. In most cases for 2dF/6dF, the default ‘all fibres’ option is probably the one required. It really only becomes important if you want to distinguish between the two 2dF/AAOmega spectrographs.

3.7 Magnitude filter

There is a magnitude filter dialogue that allows you to specify that only targets within a given magnitude range are to be included. Targets in the input file outside that range are ignored (with the exception of guide targets). This allows you to have a large number of possible targets in a field and to produce a number of configurations that cover these in specified magnitude bands.

3.8 SKYCAT lists

The 'list' option in the file menu now provides an option for output in a format that can be read into the ESO 'skycat' program. It is now easy to read this file into skycat and see the targets displayed over an image of the field. For more details see section 5.5.

3.9 Speed and algorithmic changes

The algorithms used by the configuration program have been revised and modified. The 'swap' phase of the 'iterative' algorithm traditionally used by 2dF/6dF, particularly for the redshift survey, now examines a large number of potential swaps that were being unintentionally omitted by the previous implementation of the algorithm. The result is that that iterative algorithm now produces configurations with significantly more fibres allocated. This is, however, at the expense of the time taken, which has increased, particularly when there are a large number of targets in the field. The program is now much more responsive during the swap phase, allowing the allocation to be cancelled easily if it is taking too long.

Note that the above paragraph applies to the 'Oxford' or 'iterative' algorithm implemented in the 'configureTrad' executable. The simulated annealing algorithm is quite new and its characteristics are described in a later section of this manual.

3.10 Allocation of targets to a particular Spectrograph

For 2dF, it is now possible to specify in the input file that a program object may only be allocated to a particular spectrograph.

3.11 Control of which Fibres are used for Sky.

A new expert mode option has been added to allow the user to specify the minimum and the maximum fibre numbers that may be automatically allocated to sky targets. This was added to allow for a specific program that required sky targets to be located toward the center of the CCD chips.

4 Using CONFIGURE

This section provides a description of how 2dF observers should use CONFIGURE to prepare configuration files. This section attempts to be brief; more details can be found in the rest of the manual. If this section seems too brief, or if you have problems running the program with your own files, you should try following the detailed tour in chapter 10 in order to become familiar with the program.

4.1 Initial preparations

You need to know the following things:

- Where your target field is. You need to know:

A central position, preferably in J2000 coordinates.
A name for the field.

The name can be anything you choose. You can modify the field centre position slightly in CONFIGURE, but you need a good initial position.

- When you intend to observe it.

  You need to specify a day. You probably don't know this exactly, but you can make a reasonable guess.

- What targets you want to observe. You need a list of targets, and for each one you need:

  A name.
  The position, preferably in J2000 coordinates.
  The magnitude.
  The target type.
  A priority.

  The magnitudes are recorded in the output files, but are otherwise ignored. Targets of high priority are allocated to fibres in preference to ones of lower priority. Priorities are classified as a numeric code from 1 to 9, with 9 the highest priority. The target type determines what fibre types can be assigned to the target, so you need to know which targets are to be observed with which instrument. For 2dF/6dF, guide fibres can only be allocated to guide targets. Other fibres can be allocated to any program object.

- The locations of some reference stars

  You also need to supply a number of stars that can be used as reference objects by the guide fibres. At least three of these need to be included in the configuration, so you should supply a number of possible reference stars, arranged throughout the field.

- Some sky positions

  You can handle sky in more than one way, but the most control over sky is obtained by providing explicit sky targets – coordinates that refer to blank sky – in the target list. Alternatively, CONFIGURE can generate a 'sky grid' of possible sky positions, but it cannot guarantee that these actually represent blank sky. However you allocate sky targets, you should ensure that your configurations have enough sky targets allocated to fibres.

4.2 Preparing the input file

Most the information listed in the previous section needs to be supplied to CONFIGURE in a text file. Such files are usually called '.fld' files, since that is the usual extension that they use. These can be created using an ordinary editor, but it is more likely that the bulk of the file will be created using a program. The format of the file is detailed in section 6 but it has a short initial section describing the field itself and then a series of lines each one of which describes

one target object. (Some of which describe reference stars and some of which describe sky positions.)

The field details at the start of the file might look like this:

```
LABEL 2dF test field
UTDATE 2002 07 07
CENTRE 00 34 37.20  -43 28 12.00
EQUINOX J2000.0
```

And the following might be lines describing individual targets:

```
F02          00 30 42.62  -43 47 02.11   F   9   13.65  0  fiducial star
F03          00 31 39.02  -42 48 01.75   F   9   13.74  0  fiducial star
F04          00 32 16.06  -43 51 05.29   F   9   13.64  0  fiducial star
F05          00 32 20.19  -43 01 41.91   F   9   13.40  0  fiducial star
OBJECT_01    00 29 30.66  -43 11 41.24   P   9   21.32  0  #11
OBJECT_02    00 30 39.74  -42 53 49.42   P   9   20.65  0  #22
OBJECT_03    00 31 23.87  -43 09 40.77   P   9   19.71  0  #27
sky-01       00 29 42.33  -43 19 31.72   S   8   99.9   0  blank sky
sky-02       00 29 51.85  -43 49 40.91   S   8   99.9   0  blank sky
sky-03       00 29 57.31  -43 03 26.69   S   8   99.9   0  blank sky
sky-04       00 31 51.59  -43 56 06.00   S   8   99.9   0  blank sky
```

Each of these sample lines describes a target of a given type, distinguished by the single letter target type code that follows the coordinates. ‘P’ is a ‘Program’ object – a target that can be assigned to any spectrograph , ‘S’ is a sky position, and ‘F’ is a reference star target (a ‘fiducial star’) for the guide fibre bundles. For 2dF, program objects may also be described by a two letter code. 'P1' is a Program object that may only be assigned to spectrograph 1 and 'P2' is a Program object that may only be assigned to spectrograph 2.

It is possible to generate a number of configurations from the same input file. If you intend to observe the same field with different combinations of fibre types you can include the targets for all fibre types in the one file and generate different configurations with different fibre types enabled. This is probably not a likely option for 2dF/6dF. If you have a large number of targets in the same field you can put them all in the one file and generate a number of configurations until all the targets have been allocated.

4.2.1 AAOmega Object specific wavelength settings

The Configure software must handle atmospheric refraction effects when working out the positions of fibres on the field plate – including the effects caused by different observation wavelengths. Normally, there is a wavelength chosen for all fibres on a spectrograph. This can be changed using the “Set Wavelength” command. The impact of this wavelength setting is to change the position at which a fibre is presumed to be placed, which can impact the allocation. At observation time, the position is recalculated based on the actual observation wavelength (and atmospheric weather conditions etc). If you configure for a significantly different wavelength from which you actually observe, then your field may become invalid.

The AAOmega spectrograph has a very wide wavelength range and is a dual beam spectrograph. It is possible you may prefer to have fibres configured for different wavelengths – say a set of objects intended for the red spectrograph and a set intended for the blue and another set intended for both arms. It is (since August 2006) possible to specify up to 9 different wavelengths. You do this as follows.

1. In the field header of the configuration file, specify a set of wavelengths of the form "WLEN<n> <λ>"

   Where <n> is an integer in the range 1 to 9 and <λ> is a wavelength specification in Angstroms.

2. For each program object type, originally P, you may now append a wavelength selector of the form "_w<n>" where n is in the range 1 to 9.

3. Configure the field and specify the resulting file to the 2dF observing file. The spectrograph wavelength specified in the 2dF Positioner GUI will become the default wavelength (used when not specified, and for Sky objects). All fibres that have a specific wavelength will be positioned optimised for the specified wavelengths. The 2dF data files now have a "wlen" field in the binary table, associated with each object to indicate the actual wavelength the object was configured for.

For example:

The field details at the start of the file might look like this:

```
LABEL 2dF test field
UTDATE 2002 07 07
CENTRE 00 34 37.20  -43 28 12.00
EQUINOX J2000.0
WLEN1 3000
WLEN2 4000
WLEN3 5000
```

And the following might be lines describing individual targets:

```
F05          00 32 20.19  -43 01 41.91   F    9   13.40  0  fiducial star
OBJECT_01    00 29 30.66  -43 11 41.24   P_w1 9   21.32  0  #11
OBJECT_02    00 30 39.74  -42 53 49.42   P_w2 9   20.65  0  #22
OBJECT_03    00 31 23.87  -43 09 40.77   P    9   19.71  0  #27
sky-01       00 29 42.33  -43 19 31.72   S    8   99.9   0  blank sky
```

Here objects 1 and 2 have specific wavelengths (3000 and 4000) whilst object 3 and the sky object will use the default. The valid wavelength range is 3000 to 10000, but consider your spectrograph configuration.

4.3 Running CONFIGURE

You obtain a copy of the various files needed by CONFIGURE from AAO, and install them in a directory on your local machine. Where you choose to do that is up to you. Note that it is very important to have the latest versions of the various instrument files, and that for 2dF there are a number of different calibration files that depend on the declination of the target fields. Make sure you have the appropriate files. For more details see the AAO 2dF web site. For simplicity here, we assume the directory containing all these is in your execution path, so just typing the name of an executable file in it will run that program. The CONFIGURE executable is called 'configure'. The most convenient way to run it is probably to have a working directory in which you have your .fld files and in which you will generate your configuration files. With your default set to that working directory, type

```
configure &
```

This will start up CONFIGURE. There is a standard basic sequence that will guide you through the steps needed for a standard configuration. The basic sequence window is shown in Figure 14, and a configuration can be created and saved simply by clicking its buttons in order. (The tour through CONFIGURE in the appendix - section 10 - shows the user interface in detail as one follows this sequence.) Essentially, you have to do the following:

- Set a magnitude filter to reduce the number of targets read from the .fld file, if necessary.
- Read in the details of a target field from the .fld file.
- Optionally specify the fibre combination to be configured.
- Perform the allocation of fibres to targets.
- Save the resulting configuration in an SDS file.

Each of these steps corresponds to one button in the basic sequence window.

4.4 Reading in a target file

The program has no preset limit to the number of targets it can handle, but in practice it starts to run slowly (particularly when displaying) if it is dealing with more than a couple of thousand targets. Some of the allocation algorithms, particularly the 'iterative' algorithm, become extremely slow with more than a few hundred unallocated targets. If you have too many targets in your input file, you should apply a magnitude filter so that only targets in the same magnitude band are handled at one time. (The filter does not apply to reference stars.) To apply a magnitude filter, click on the 'magnitude filter' button in the basic sequence window and enter a pair of limiting magnitudes. Then click on 'apply'.

To read in a target file, click on the 'open file' button in the basic sequence window. Then select the file (usually a .fld file) in the file selection dialogue. The field will be displayed, together with all the fibres.

4.5 Specify the fibre combination

Click on 'Fibre combination' in the basic sequence window. A list of possible fibre combinations appears. You should select the one you want to use and click 'apply'. The

default is ‘all fibre types’, including guide fibres, and this is usually what is needed for 2dF or 6dF.

4.6 Perform the allocation

Click on the ‘allocate’ button in the basic sequence window. A dialogue window appears offering you various options that control the details of the allocation process. Usually, the default values will be fine, and all you need to do is click the ‘OK’ button. You should check the number of sky targets that are to be allocated. If you are using fibres that can be allocated to either sky or non-sky targets it is usually best to tell the program explicitly to allocate a certain number of sky targets to each fibre type. If you have too few sky fibres allocated you may not be able to get the best out of your data when you reduce it.

Section 7.10 provides more details of the allocation process and explains the various options.

The total number of fibres allocated is shown in the basic sequence window. More details, including the number allocated to reference stars and to sky targets are shown in the control panel. You should check that you have enough sky and reference targets allocated to fibres.

If the allocation is unsatisfactory for any reason, you can try again with different parameters (in which case you should select ‘remove allocations’ from the ‘commands’ menu first). Or you can make minor corrections to the allocation by hand, selecting targets and fibres by clicking on them and either explicitly allocating or deallocating them. This is described in more detail in other parts of this manual.

4.7 Saving the configuration

Click on the ‘Save as SDS’ file button in the basic sequence window. A file save dialogue will allow you to specify the name and location of the file to be written. The default name for the file is generated automatically from the name of the input .fld file. This file is a binary file and it is not practical to try to modify it other than by reading it back into CONFIGURE. If you need to e-mail such a file of transfer it using FTP you should ensure that it is transferred as a binary file. In general, before transferring these files you should gzip it first, then transfer the gzipped file and gunzip it on the receiving machine.

Note: The program will not allow you to save a configuration for which there are fewer than 3 three guide stars allocated. This is a safeguard to ensure that you do not forget to allocate guide stars for your observation. If you really want to save a configuration with fewer than three allocated guide stars, you can do so if you switch the program to ‘expert’ mode first.

4.8 Exit the program

Click on the ‘Exit’ button in the basic sequence window to exit the program.

4.9 Additional checks

The basic sequence described above will usually generate perfectly satisfactory configurations. However, you may want to perform some additional checks yourself.

Changes in central wavelength and hour angle introduce small changes in the position of target objects in the field. CONFIGURE configures its fields for a specific hour angle and central wavelength. If the actual observation is made under radically different circumstances, the target positions will change and in some circumstances these changes can result in two fibres being positioned too close together, or the maximum bend angle for a fibre being exceeded. CONFIGURE allocates using more restrictive tolerances for such things as button/fibre clearances and maximum fibre bend angles than does the actual positioner. This means that configurations generated by CONFIGURE should be valid over a wide range of hour angles and various central wavelength values. Allocations that are performed by hand use the same tolerances as the positioner. This means that manually allocated fibres are potentially less tolerant of changes to the central wavelength or hour angle than allocations that are performed automatically. You may wish to test your field. You can change the central wavelength using the ‘Set Wavelength’ option in the ‘Commands’ menu, and can then check the validity of your fibre allocation at this new wavelength using the ‘Check Allocation’ option in the ‘Commands’ menu. You can check the validity of the allocation over a range of hour angles using the ‘Check over HA range’ option in the ‘Commands’ menu.

5 Some additional features

This section describes in a relatively informal way some of the additional features of the program.

5.1 Using the Mimic window

A number of features are available as you move the cursor around the mimic window. Some of the more useful are as follows:

You can zoom in and out using the 'zoom' menu in the main panel, but you can also zoom in by a factor two by clicking the right mouse button in the mimic window. You can zoom out by a factor two by control-clicking the right mouse button in the mimic window.

As the cursor moves over a fibre, the fibre number and type are displayed at the top information pane of the screen. If you click on a fibre, this selects the fibre. As the cursor moves over a target, the target name and type are displayed at the top of the screen. If you click on an unallocated target, this selects the target. (It's hard to click on an allocated target, because the fibre covers it and you select the fibre instead. In practice, however, you rarely want to select an allocated target – selecting the fibre is usually what you want to do.)

If you have selected an unallocated fibre and an unallocated target, you can use the 'allocate target' option in the 'commands' menu to allocate the selected fibre to the selected target. (Or you can use the 'F3' key instead.) If you have selected an allocated fibre, you can use the 'deallocate fibre' option in the 'commands' menu to deallocate it. (Or you can use the 'Del' key instead.) This allows you to impose your own choice of allocations if you really want to do so.

5.2 Different allocation algorithms

The program supports a couple of different allocation algorithms, and these can all be run in a number of different ways. These are controlled by the options presented to the use by the dialogue box displayed when the **'Allocate…'** option is selected. These are described in detail later in this document.

5.3 Uncrossing fibres

It is possible to explicitly invoke a version of the allocation algorithm than only attempts to reassign already allocated fibres in order to reduce the number of crossovers of fibres. This can be done by selecting **'uncross fibres…'** from the **Commands** menu. The fewer crossovers there are in a configuration the faster it is for the fibre positioner to reconfigure the field.

Note that this option only works with the 'Oxford' algorithm implemented in the 'configureTrad' executable. The simulated annealing algorithm has an allocation option that controls the 'straightness' of the allocations, that is, how much the fibres deviate from a radial

line from their pivot points to the field center. A very 'straight' configuration will have few crossovers, and if this is important you should select the 'heavy' straightness option. If 'never' is selected for the straighten fibres option in the allocate dialogue, the annealing algorithm will aim for maximum fibre allocations and may create a very heavily crossed configuration.

5.4 Multiple configurations to cover a target list

If you have a large number of targets then you may want to try to create a number of configurations that will cover all of the targets. The program is not optimised for this mode of operation, but it can be used in this mode.

After a first configuration, which will, of course, only have allocated fibres to a small subset of the targets available, select the **'List…'** option from the **'File'** menu. A dialogue box will allow you to control what is output to the list file. Select the **'unallocated objects'** option. This will produce a new target list that contains only the unallocated targets and the reference targets. (All guide fibres are included, even those allocated in the present configuration, since they can sensibly be reused in the next configuration.). You are then prompted for the name and location of the new list file.

You can then select the **'Open…'** option from the **'File'** menu and specify this new target list as the input file. You now have all the targets except for those non-guide targets allocated in the previous configuration. You can create a new allocation and repeat the process.

(This will get tedious if exhaustive coverage is needed – i.e. if the intention is to cover all the targets in the input list – and the final configurations will have relatively few targets. The tediousness can be addressed by automating the procedure if this is going to be useful. These are aspects that need further discussion based on experience with the program.)

5.5 Viewing allocations using Skycat

You may want to see the allocated targets plotted against an image of the sky. In particular, if you have sky targets you may want to check on whether or not these really do represent blank sky. CONFIGURE can generate catalogue files in the standard ESO catalogue format containing all the allocated targets, and these can be read by the ESO SKYCAT program.

To do this, select the **'List…'** option from the **'File'** menu, and select the **'Allocated objects in Skycat format'** option from the dialogue box that comes up. You are then prompted for the name of the catalogue file to be written.

If you now run Skycat, you can read this newly created catalogue file as a local catalogue file. (Use the menu sequence **Data-Servers -> Local Catalogs -> Load from file**.) If you do so immediately after running Skycat, with no image displayed, Skycat will default to a display centered on the center of the field that was allocated, and will show some of the allocated targets around the center of the field. To get the allocated objects displayed on a sky image, use the 'Image servers' sub-menu. (The usual menu sequence is: **Data-Servers -> Image Servers -> Digitized Sky at ESO**.) The center of the field will already be set, but you should increase the size of the field to be somewhere in the range 25 to 30 arcmin, depending on how

much of the field you want to see. An image will be retrieved from the image server, and will be displayed with the allocated targets superimposed on it.

By default, sky targets will be displayed as white squares, reference stars (guide fibre targets) will be displayed as white diamonds, and all other targets will be displayed as white circles. Skycat experts can change these defaults. The catalogue as written by CONFIGURE contains a text entry that describes the target type precisely, and numeric entries that indicate whether or not each target is a sky target or a reference target. There is one dummy target included in the catalogue, the first one listed, that indicates the center of the field.

5.6 Disabling use of some fibres - particularly for 2dF charge shuffling.

There are cases where you will want to disable some fibres from being used by configure. In particular, if you are using 2dF-AAOmega charge shuffling – where you only want to configure every second fibre. For 2dF, a program exists to help you do this – **`set_fibre_state`**.

This program is released with configure and must be run before you configure a field. It will modify the file tdFconstants400.sds as requested. You can request that fibres be disabled appropriately to configure for charge shuffling or you can disable fibres based on a user supplied list.

If you run this program without any arguments it will output up to date help on how to use the program.

6 Detailed input file format

This section refers to the text file that is used the first time a set of targets are presented to CONFIGURE. Usually these are files with a .fld extension, although that is not necessary. These files are prepared by the astronomer – possibly using a purpose-built program to do so.

The file consists of lines of up to 256 characters. Comment lines can be indicated by an asterisk character ('*') or a hash character ('#') in the first column. At the start of the file, there should be a series of lines that describe the field itself, as opposed to the individual targets it contains. Special characters, particularly quotes, should be avoided. Each of these lines must begin with one of the following keywords (which may appear in any order):

LABEL A string giving the target field label.
UTDATE The UT Date of observation.
CENTRE Field Centre R.A. and Dec. (hh mm ss.ss -dd mm ss.s)
EQUINOX Coordinate equinox – eg. J2000.0
ARGUS Argus angle and scale values.
WLEN<n> Where <n> is from 1 to 9. Specific wavelength value.

Any non-comment line that does not start with one of these keywords will be assumed to signal the start of the target list. The ARGUS line is meaningless for 2dF/6dF, referring to a feature of the ESO FLAMES instrument, and is ignored if that instrument is not being used. The equinox of all coordinates given in the file must be that specified in the EQUINOX line. The EQUINOX line is optional and if omitted defaults to J2000.0.

LABEL can be followed by any text. It does not have to be enclosed in quotes.
UTDATE must be followed by the date in the format yyyy mm dd[.dd]. The fractional date shown here as [.dd] indicates that a time of day can be included as a decimal fraction of a day.
CENTRE must be followed by an RA and Dec in the format hh mm ss.ss [-]dd mm ss.s. The [-] indicates an optional sign.
EQUINOX, if supplied, must be followed by the string J2000.0. For FLAMES the use of J2000.0 is mandatory – other instruments allow other equinox values to be specified.
ARGUS, if supplied, must be followed by a position angle in degrees and a string specifying the ARGUS scale. The scale string must be either '1:1' or '1:1.67' (the quote characters are not required). Note that this is not relevant to 2dF or 6dF.
WLEN<n> if supplied, where <n> = 1 to 9, specifies an object specific wavelength specification. It must be followed by a wavelength in angstroms, in the range 3000 to 10000.

Subsequent lines describe target objects, one per line. Each line consists of a number of items separated by spaces. The first four items are mandatory as follows:

Name The name of the object (by convention F<n> is used for reference stars) Note that this cannot contain spaces.
RA (hh mm ss.ss)
Dec (-dd mm ss.s)
Type One character indicating the type of object. The allowed types are listed below.

Priority (1-9) with 9 being the highest priority. If you are not using priorities you should set all priorities to the same value, say 1.
Magnitude (mm.mm)
Program Id An integer which uniquely identifies a specific project. At present, this is ignored. Any number may be used.
Comment Any remaining text up to the end of the line

6.1 Additional items embedded in comments

CONFIGURE allows a number of optional additional items of information about target objects to be included in the input file. This is another feature introduced for FLAMES, and is probably not applicable to 2dF/6dF, although they are still supported. These are included in the comment field, and take the form of strings

(Name)=value

or

(Name=value)

These can be delimited by commas, blanks, or semi-colons, and should be at the start of the comment string. The following names are accepted within the parentheses.

BAND Band designation for the magnitude specified (B,V,R)
B-V Object colour index, B-V
V-R Object colour index V-R
PM-RA Annual right ascension proper motion for the equinox J2000 in the FK5 system in arcsec per year.
PM-DEC Annual declination proper motion for the equinox J2000 in the FK5 system in arcsec per year.
SNR Signal to noise ratio requested by the observer.
CATEGORY Object morphology: Stellar or Extended
DIAMETER Source extension diameter for extended objects, in arcmin.

6.2 Possible object types:

The following letters are accepted in the 'Type' field for an object:

P Program object. For 2dF and 6dF, this indicates a target that should be assigned to a single fibre connected to one of the spectrographs.
P1 Program object that may only be assigned to spectrograph 1. This applies to 2dF only.
P2 Program object that may only be assigned to spectrograph 2. This applies to 2dF only.
S Sky. This indicates a position that can be used for sky. Such a target may be assigned to any spectrograph fibre.
F Fiducial (reference star). This indicates a target that should be assigned to a guide fibre.

For FLAMES, a large number of other object types are supported. For details, see the FLAMES manual.

For AAOMega, P may be suffixed with "**_w<*n*>**" where <n> is 1 to 9. This will indicate a specific wavelength specification for that object – the wavelength used to account for atmospheric refraction effects both during configure and when positioned by the robot. See the **WLEN<*n*>** specification in the header for the actual wavelength value.

6.3 Example Text Input File

```
* This is a comment line
LABEL target field number 1 xyz cluster
UTDATE 1994 05 12
CENTRE 12 43 23.30 +10 34 10.0
* end of required header info
*
F1   12 40 20.55 +10 30 11.4    F   6  12.0  1  brightest star
F2   12 38 10.31 +09 59 58.9    f   6  13.5  1  fiducial star
*
NGC1002  12 41 30.55 +10 31 56.9  P 9  15.0  1  small fuzzy galaxy
ic3082   12 40 18.40 +10 32 21.5  P 9  *     1  candidate satellite
*
sky-1   12 40 10.00 +10 32 21.5   S 3  *     1  blank sky (checked)
```

7 The CONFIGURE program

This section is a more formal description of the CONFIGURE program.

The CONFIGURE program is used to perform the following main functions:

- Performing the allocation of objects to fibres in a 2dF/6dF field.
- Checking the validity of fibre allocations over a range of dates and hour angles.
- Generating a file describing the field configuration and allocations that can be used as input to the 2dF or 6dF observing systems.

7.1 Running the CONFIGURE program

The program is started with the command **configure** typed at the UNIX shell prompt. This will bring up three windows. The control window contains a menu bar, status display, and message region. The largest window – the 'mimic' window – will be used to display a graphical representation of the configuration being generated. A 'basic sequence' window provides a guide through a basic sequence of operations needed to generate a configuration for 2dF/6dF.

7.2 Opening files

The configuration program can read data from three types of file:

- Text files containing a description of the field in the standard format described earlier in this document. These are lists of targets and contain no fibre allocations. The default extension for these files is **.fld**.
- Configuration files in the standard FLAMES format used at ESO. These are PAF files used as input by the FLAMES observation software, and will invariably have been created by the configuration program itself. It is possible to use PAF files as intermediate files for 2dF/6dF configurations, although there is almost nothing to be gained by so doing. There may be cases where the fact that PAF files are human-readable text files may be useful, but you would need to know the detailed format to make use of it. In general, you will not use PAF files for 2dF/6dF configurations.
- Configuration files in the binary SDS format used by AAO. This format is the default output format used by CONFIGURE for 2dF/6dF configurations. They can also be read in by CONFIGURE. This format is required by the 2dF and 6dF instrument control software.

Note that an astronomer will always start by generating a text file describing the targets in a field. From this, a number of different configuration files can be generated in SDS (or, unusually, PAF) format. If the astronomer or the operations staff want to check or modify a configuration then these files can be read back into the configuration program and new versions can be created.

To open a configuration text file select **Open…** from the **File** menu and select your file using the file selection dialogue that appears. By default, a file extension of .fld is expected for configuration text files. Alternatively, select the **Open File** option from the basic sequence window. If an input file contains a large number of targets, you may want to set a magnitude filter first to restrict the targets considered by the program to those within the magnitude range specified. To do so, select the **Magnitude Filter** option from the basic sequence window.

To open an SDS configuration file select **Open SDS…** from the **File** menu and select your file using the file selection dialogue that appears. By default, a file extension of **.sds** is expected for SDS configuration text files.

To open a PAF configuration file select **Open PAF…** from the **File** menu and select your file using the file selection dialogue that appears.

On opening your file the status display will show a summary of information about the field, and the objects in the field will be drawn in the mimic window. In the case of a text file no fibre allocations will be present, so the fibres will all appear in the mimic display at their park positions. A PAF or SDS file may already include fibre allocations and these will be shown on the display. To remove any existing allocations in order to start from scratch use **Remove Allocations** from the **Commands** menu.

7.3 Converting Files

The configuration program can be used as a way of converting configuration files between text and SDS or PAF formats, in either direction.

To convert a text configuration file to an SDS configuration file, use **Open…** from the **File** menu to open the file, then use **Save** or **Save As…** to save the file in SDS format. This sequence can be performed non-interactively using the –d switch on the command line when configure is invoked. (See the section on running in batch mode.)

To convert an SDS configuration file to a text file, use **Open SDS…** from the **File** menu to open the file, then use **List…** to output the file in text format. The output file produced by **List…** is a valid configuration text file containing the unallocated objects from the configuration file. (**List…** always uses an equinox value of J2000 when writing its output files.) It may also include a listing of the fibre allocations in the form of comments in the listing.

7.4 Setting the Wavelength

Before allocating fibres it is important to set the desired observing wavelength. It is possible for an allocation that is valid at one wavelength to be invalid at another wavelength. Therefore, use the **Set Wavelength…** option in the **Commands** menu to set the desired central wavelength of observation. For 2dF, if the two spectrographs will be obserbing at different wavelengths, it will be necessary to choose a single observing wavelength that will be a reasonable compromise between the two actual observing wavelengths. A future version of configure will allow separate observing wavelengths to be set for each spectrograph.

7.5 Setting the Field Plate

For some instruments, you may want to configure for a particular plate, for example when running online during a telescope run, or checking a field for the telescope. This is necessary because both plates always have different fibre and astrometry information.

For AAOmega, although there are physically only two field plates available, the program provides the option of three field plates. Plate 0 is a plate that uses a combination of the fibre data for both plates – a fibre broken on either plate shows as broken on plate 0, and the fibre pivot positions are the average positions for the two actual plates. The intention is that an allocation made for plate 0 will be valid for either of the two actual plates. The disadvantage of using plate zero is that to ensure that such an allocation is valid for either plate, particularly over a range of hour angle values, the tolerances on such things as allowed pivot angles need to be made more restrictive than is necessary when a single specific plate (plate 1 or plate 2) is being targeted. This means that the allocation yield, in terms of the number of fibres that can be allocated, is usually less for plate 0 than for the other two plates.

For FLAMES, it was decided that any configuration *must* be valid for either plate. The plate data used by FPOSS is therefore a combination of the data for the two actual plates (so a fibre broken on either plate will show up as a broken fibre, for example).

To set the desired plate use the **Set Field Plate…** option in the **Options** menu. The default is to use plate 0, but this can be changed using the –p command line option. FLAMES can only accept plate 0. For 6dF, the field plates are known as plate 1 and plate 2, rather than 2dF's plate 0 and plate 1. In AAOmega, the actual plates are plates 1 and 2, while plate 0 is the virtual plate whose configurations can be used for either actual plate, as described above.

7.6 Overview of the Allocation Procedure

Automatically allocate fibres by selecting **Allocate…** from the **Commands** menu. This will bring up a dialogue box with a number of parameters controlling the allocation process. The default parameters will normally be suitable. During the allocation process, which will typically take under a minute to complete, a progress window will report on the progress of the allocation, and the mimic window and status display will be updated as new fibres are allocated.

The default is to leave no fibres unallocated if possible, but you can specify a number of fibres to be left unallocated for sky targets. Once the object allocation is complete you can assign these to sky positions. These can either be generated on a standard grid (using **Allocate Sky Grid…** from the **Commands** menu) or they can be supplied in the input file. Alternatively, you can add sky positions manually.

Once the allocation is complete, it will be checked for validity at the current position. As an extra step, you should select **Check Over HA Range** from the commands menu to check the validity of the field over a range of hour angles (the default is to check for plus or minus four hours from the meridian on the date set by the UTDATE field in the input file).

Saving the configuration as an SDS file will now give you an input file for the 2dF or 6dF positioner. You should ensure that all the available guide fibres were selected.

7.7 CBS pairs

The AAOmega concept of CBS pairs is supported by the simulated annealing algorithm. You can introduce cbs pairs in the initial target list, or using the **Generate CBS pairs** option in the **Commands** menu. If an object has a name, say, 'galaxy1', its CBS pair is an object with the name 'galaxy1-cbspair'. The '-cbspair' suffix is all that identifies the CBS pair object, so it is possible to set these explicitly in a target list. However, is it far more convenient is to use the menu option to generate CBS pairs for all program objects automatically.

7.8 The Allocation Procedure in detail

The above recipe will suffice for the majority of fields. The hardware constrains the fibres to an angular limit from the radial direction which is instrument-dependent, but fibres are allowed to cross multiple times and in most cases all of them can be allocated to targets.

In the default 'configure' executable, there is only one allocation algorithm used. This is the new simulated annealing algorithm. This makes use of the computational power of modern computers to work through the parameter space of all the possible allocations trying to converge on an optimal configuration. What constitutes an optimal configuration depends on the weight given to different aspects of a configuration, such as the relative weights given to straightness of allocations (ie. mimimising crossovers) and allocating as many fibres as possible. In general, the annealing algorithm gives excellent results, but you pay a price in terms of the time taken for a configuration and the memory needed by the algorithm. In general, both of these effects scale as the square of the number of targets. If you have a lot of targets in your field, you should apply a magnitude filter to reduce them to a tractable number if possible.

In the 'configureTrad' executable, there are two basic allocation algorithms available, and these can be selected using the allocation dialogue panel – this can be seen in Figure 24. These are the 'Oxford' algorithm, also known as the 'iterative' or 'cones' algorithm, and the 'Taylor' algorithm, which has a number of variations such as 'straightest target', 'hardest target', 'most crowded target'. There are then two additional options that you might want to consider, the tentative deallocation option and the fibre uncrossing option. You can also specify how many sky targets you want allocated to the various fibre types (in the case of 2dF/6dF this means that you choose how many sky targets you want allocated to the two spectrographs).

In general, the main determinant of which traditional algorithm to use is the number of targets you are trying to deal with. If you have more or less the same number of targets as you have fibres, then you will generally get the best results using the 'Oxford' iterative algorithm, bypassing tentative deallocation, and with a final uncrossing pass. If you have a large number of targets, you may find this too slow an algorithm. In this case, you are usually best off with the 'hardest target' variation of the 'Taylor' algorithm, followed by both a tentative deallocation pass and an uncrossing pass.

In general, we recommend the use of the simulated annealing algorithm, unless you are trying to run this on a slow machine with limited memory. In that case, you may prefer to fall back on the traditional version of the program.

Experienced users will have their own preferred recipes, often using some of the additional options made available in 'expert' mode. (Even experienced users, however, will find that the current version of CONFIGURE has made changes to the 'Oxford' algorithm, particularly in the swap phase, that may mean they should reconsider some of their recipes. The swap phase now takes longer, but generally results in rather better configurations with may need less post-allocation optimisation.) Those prepared to spend time in the search of the ultimate configuration may use the individual allocation and deallocation facilities offered by the user interface, allocating and deallocating fibres by hand.

7.8.1 The 'Simulated annealing' algorithm

The simulated annealing algorithm performs a guided search through the parameter space of all possible allocation combinations, trying to maximise the quality of the configuration. The details of how it does this are beyond the scope of this document. What matters to the user is that the algorithm calculates a value for each configuration it considers which measures the overall quality of the configuration, as determined by a number of parameters. The different quantities included in this overall value (such as number of allocations at different priorities, the straightness of the configuration, etc.) are given different weights depending on the allocation parameters, as set in the allocation dialogue.

7.8.1.1 Performance considerations

One internal consideration that does need to be discussed here is that of the 'incompatibility matrix'. In order to be able to pass through a huge number of possible configurations as quickly as possible, the algorithm pre-calculates a matrix showing which of the possible allocations are mutually incompatible. The reason that this matters is that this is a two-dimensional array with each dimension given by the total number of possible allocations of fibres to targets. Simple-mindedly, the total number of possible allocations is simply the number of fibres times the number of targets. In practice, however, many of these allocations are invalid, even without considering the question of whether or not they interfere with other allocations. Not all fibres are compatible with all targets, and many fibres simply cannot reach some targets. The code allows for all this, and holds the incompatibility matrix in a compressed (sparse) form. However, given that the number of fibres is effectively constant, the size of the incompatibility matrix (and the time to calculate it) goes as some not quite linear function of the square of the number of targets.

This means that the initial calculation of the incompatibility matrix can require a deal of CPU time, and the matrix itself can require a deal of memory, both scaling as the square of the number of targets. This makes it important to try to reduce the total number of targets as much as possible, to keep the problem tractable.

If the time to calculate the matrix, or its final size, are excessive, an expert mode parameter can be used to perform what is described as ‘sparse sampling’ of the allocations. This allows the user to specify that only a certain percentage of the possible allocations are to be considered. The algorithm tries to remove from consideration those allocations it feels are unlikely to be used – allocations to low priority targets than can be reached by a large number of other fibres, for example. Remember, setting this percentage to 50% will halve the number of allocations considered, and so will decrease the matrix size and calculation time by around a factor 4.

The algorithm saves the incompatability matrix to disk once calculated, and if it has to repeat an allocation with exactly the same set of target locations (note that these change with hour angle, atmospheric parameters, etc), it will re-use the saved matrix.

In summary: try not to have too many targets, and if you do, select ‘expert’ mode to reduce the number of allocations the algorithm needs to consider.

7.8.1.2 Allocation dialogue options

The allocation dialogue used for the simulated annealing algorithm is shown in Figure 23. The options provided are:

Annealing There are a number of internal parameters used to control the details of the annealing, but these are obscure and instead of making them available directly, three settings for the thoroughness of the annealing have been provided. These essentially trade speed against thoroughness. ‘Quick’, ‘Standard’ and ‘Thorough’ should be self-explanatory.

Weight Close Pairs Applies an increased weighting to targets separated by between ThetaMin and ThetaMax arcsec. This biases the algorithm towards targets that are in crowded parts of the field, if ThetaMax is small (the default is zero). This does *not* have to be enabled to enable use of the Cross Beam Switching parameter.

CrossBeamSwitching Weights CBS pairs. When CBS pairing is being used by AAOmega, a single actual target is observed using two target positions. One would be at the correct position named "galaxy" say, and its offset pair would be named "galaxy-cbspair". The "-cbspair" suffix is used by configure to optimise the yield of these pairs. The algorithm is biassed towards allocating both halves of a CBS pair if this option is selected.

Straighten Fibres Controls the importance attached by the algorithm to having fibres configured as radially as possible. The trade-off here is between limiting the number of cross-overs (and hence the reconfiguration time) against the number of fibres that can be allocated. Three options are provided. ‘Never’ gives the best target yields, paying no attention to straightness, but because the algorithm is capable of very high allocation rates, it is also capable of generating highly crossed configurations. ‘Moderate’ does affect target yields but gives reasonably straight fibres. ‘Heavy’ may well be overdoing it. If you have the time to experiment, try all three and see the effects they have, both on the complexity of the configuration and the number of fibres allocated.

Collision matrix filename The name of the file used to store the collision matrix (the incompatibility matrix) in the default directory. Files can be quite a large, so usually the program overwrites the last file with the latest one. If you want to be able to go back to a field and re-do it, using a different file name will allow you to do so without needing to go through the slow recalculation of the matrix again. The code can tell if a saved matrix file matches the target and fibre combination it is trying to configure. Deleting matrix files after a configuration means they will need regenerating if the combination is revisited, but has no other effect.

Enforce Sky Quota By default sky targets are included in the randomisation process. Once sky targets are allocated, they are not deallocated unless their fibre goes to another sky target. Constraints are placed to ensure that the yield of sky targets does not exceed the user quota, however no effort is taken to make sure the quota is fulfilled. In some circumstances crowding in the field may mean that the quota is not fulfilled. In these circumstances enabling the parameter gives twice the weight to sky targets to ensure the quota is fulfilled. This may negatively impact on the priority distribution as some high priority targets may be sacrificed for the now heavily weighted sky targets.

Weight peripheral fiducial targets If checked, fiducial targets closest to the field edge are given extra weight. generally, it is better to use guide stars near the edge of the plate; the fibres get in the way less, and the peripheral guide stars provide better ‘leverage’ when guiding.

Weight fiducial target pairs Only valid when CrossBeamSwitching mode is enabled. It just means that if you have fiducial targets that are CBS pairs (which can be generated by the automatic generation of CBS pairs) then the algorithm gives increaded weight to allocating these in pairs. This is not actually necessary, since CBS exists to provide improved sky subtraction, which is not what fiducial targets are there for, so there may be advantages to having this feature off. With it off, the algorithm will tend to more evenly disperse fiducial fibres around the field plate, even if there are pairs of fiducial targets. This may help in the construction of field configurations where 4 fibres are on guide stars at one telescope offset, and a different set of 4 are on guide stars in the other offset used in this observing mode.

7.8.1.3 Stages of the algorithm

The algorithm passes through a number of stages, three of which deserve mention because they are the ones that can take some time. These are the stages you will probably notice in the progress window that is displayed during allocation.

Sparse sampling is when the algorithm is passing through all the possible allocations of fibres to targets to try to work out which are unlikely to be useful and so can be removed from consideration at an early stage. If this is cancelled, there will be no fibres allocated by the algorithm. This stage is skipped if the saved incompatibility matrix can be reused.

Matrix creation is potentially quite time consuming, particularly if a large number of targets are being used. The algorithm is examining every possible combination of allocations to see which are mutually incompible (usually because of button for one allocation colliding with

the fibre or button of the other). If this is cancelled, there will be no fibres allocated by the algorithm. This stage is skipped if the saved incompatibility matrix can be reused.

Annealing is the actual annealing stage. Annealing progress can be followed from the allocation statistics panel. Generally, the algorithm allocates a reasonable number of fibres quite quickly, then spends a lot of time trying to improve both the total number of fibres allocated and the target priority distribution of the final configuration. Slowly, you should see more targets of high priority being allocated (often at the expense of low priority targets). If the algorithm is cancelled during this stage, the configuration achieved so far is kept, so it can make sense to cancel the algorithm once the priority distribution appears satisfactory. You can always repeat the allocation after looking at it in the mimic display, if you feel it is unsatisfactory (repeating an allocation is usually quite fast, since the saved incompatibility matrix can be re-used).

7.8.2 The 'Oxford' algorithm

The algorithm currently used for 2dF (developed by Gavin Dalton at the University of Oxford) is highly optimised and has proven to give the best results for 'typical' fields, particularly when the number of targets is roughly the same as the number of fibres. This algorithm is invoked by selecting the **iterative target allocation** option from the allocation dialogue. After an initial allocation it searches down a tree of multiple fibre swaps, looking for swaps that give increased allocations. The algorithm is not unlike a chess program. The tree search terminates at a depth of ten swaps where it has been found, empirically, that the expenditure of CPU time required to deepen the search is not rewarded by increased allocations.

It is worth describing the operation of the algorithm in more detail. It is sometimes described as the 'cones' algorithm, because the concept of a cone with a target at its apex is an important part of the algorithm. Imagine a target somewhere in the field. Simply because of the limitations on the amount a fibre is allowed to bend as it leaves its pivot point, there are only a limited number of fibres that are physically able to reach this target. Imagine drawing the two extreme fibres out of all these, connected to the target in question. Combined with the sector of the pivot circle between the pivot positions of these two cones, these two extreme fibres delineate a 'cone' with the target at its apex. Now, the important point is that this cone will usually include other targets, and the fibres that originate within the cone are able to reach other targets outside the cone. However, the *only* fibres that can reach the targets in the cone are those originating within the cone. Imagine that there are just as many fibres originating in the cone as there are targets in it. (This will be the case where there are roughly as many fibres as targets, all evenly distributed.) This means that if there is no excess of fibres over targets for this cone, then it is going to be important that none of the fibres are allocated to targets outside the cone. If there is an excess of targets over fibres for the cone, it becomes particularly important to allocate all the cone fibres to targets within the cone.

The algorithm therefore considers all the possible cones formed by targets within the field, and sorts them into an order of importance, regarding the most important as those with the biggest excess of targets over fibres. The targets defining these cones are the ones it attempts to allocate first. The initial allocation pass is quite simple. The algorithm takes all the highest priority targets (those of priority 9) and sorts them into order of importance based on the

target/fibre ratio for the cones they define. It then attempts to allocate targets to fibres in order of importance. It then repeats the process, this time including targets of the second priority rank (ie it now handles priorities 8 and 9). And so on, each time including lower priority targets, until it has done a pass with all targets.

This allocation process is quite fast, but generally leads to a somewhat unsatisfactory configuration, with a number of allocated fibres blocking the allocation of other currently unallocated targets. The algorithm then enters a 'swap' phase. In this phase, it attempts to improve the allocation by tentatively deallocating fibres. It takes an unallocated target (again, working in the 'cone' order of importance). Clearly, with the configuration as it stands, there is no fibre that can be allocated to this target. So it looks at each fibre that can be allocated to the target – at least on physical bend angle grounds – but is currently allocated. If there is one that can be deallocated from its current target and immediately allocated to the unallocated target, then it does so. It now has a different unallocated target. It may be that this slightly modified configuration will allow a fibre that was parked to be allocated immediately. If so, this is an immediate gain. If not, the algorithm just starts again with the new unallocated target, looking to see if there are currently allocated targets that can be swapped with it that might lead to a gain of a parked fibre. There is a safeguard that prevents the code from making 'false' gains – gains obtained by allocating more than one low priority target at the expense of a high priority target. This 'swap' phase is potentially quite time consuming, particularly if there are a large number of unallocated targets – so time consuming that you may want to avoid the iterative algorithm if you have a large number of targets. You can cancel it at any time, should it be taking too long, so there is no reason not to try it to see whether you regard the time needed as unacceptable.

7.8.3 The 'Taylor' algorithm

For fields with a large number of target objects – far more than the number of fibres – the swapping phase of the iterative target algorithm can take too long for this algorithm to be used successfully. For such fields, better results are obtained by an algorithm due to Keith Taylor. This operates in a number of different modes, and is invoked by selecting **'by most crowded**', **'by hardest target'** or **'by straightest target'** in the allocation dialogue.

This algorithm is relatively easy to understand. It assumes that the hardest pivots to allocate will be those that can be allocated (on grounds of physical constraints, such as fibre bend angle, fibre length, etc. and target/fibre compatibility) to the fewest targets. It therefore allocates the pivots to targets in order of decreasing difficulty, starting with the hardest pivot to allocate. Having decided which pivot to allocate, it then has to pick a target for it. It will allocate to the highest priority target available for that pivot. If more than one target of the same priority can be allocated, then the decision depends on just how the algorithm was invoked.

If **'by hardest target'** was selected, it picks the target that can be assigned to the fewest fibres. These targets are going to be hard to allocate, so it tries to allocate them as soon as possible.

If you selected **'by most crowded**', it picks the possible target with the least average distance to other targets. This is suitable for fields that have areas that are particularly crowded, and in

particular, for cases where the user is trying to get a number of configurations that will, together, cover a large target list. (The 'hardest target' option will often allocate a greater number of targets for a single configuration, but will do so by ignoring crowded targets, leaving these to be covered by the final configurations in a set, which is unsatisfactory.)

If you selected **'by straightest target'**, it picks the target that will bend the fibre the least. This option produces allocations with the minimal number of crossed fibres, which can be a consideration if exposure times are small and it is important to be able to reconfigure the field as quickly as possible.

7.8.4 Tentative deallocation

If you selected **tentative deallocation** in the allocation dialogue, the program performs a pass where it tentatively deallocates each allocated fibre in turn and then sees if this allows more than one other allocation to be made. If so, there has been a gain from this deallocation. The option takes a little time, but can often squeeze a few extra allocations out of a field. This option is normally only used when the main allocation is done using the Taylor algorithm, since the swap phase of the Oxford algorithm is really a much more comprehensive case of the tentative deallocation pass.

7.8.5 Fibre uncrossing

The optional final 'uncrossing' pass looks at all pairs of allocated fibres which cross to see if they can be reversed. This is important, as reducing the number of fibre crossings in the final configuration produces a significant reduction in the field setup time by reducing the number of fibres that must be parked in transit. Note that this reduction is obtained without constraining the allocation itself.

7.8.6 Sky allocations

The allocation dialogue allows you to specify how many sky targets are to be allocated to each fibre type. (This is not useful in 6dF, where sky targets can only be allocated to the 6dF spectrograph fibres, but it can be useful for 2dF, ensuring that each spectrograph gets a roughly equal number of sky fibres.) This is implemented rather simply. At the end of the allocation, the program looks to see if there were explicit sky targets specified in the target list (either in the original input file, or through the generation of a sky grid or the explicit nomination of a given position as a sky position).

If there are sky targets available, the program attempts to allocate the specified number of fibres of each type to the available sky targets. If necessary, it will deallocate low priority targets in order to free up enough fibres for the specified number of sky targets.

If no sky targets are available, the program assumes that you plan to generate a sky grid or specify sky targets explicitly, and it simply deallocates fibres allocated to sufficient low priority targets to ensure that the specified number of fibres are unallocated.

7.9 Target Priorities

The targets are allocated in order of priority, with a numerical value of 9 being the highest priority and 1 being the lowest. To ensure all guide fibres are allocated it is best to give guide targets the very highest priority values.

7.10 The allocation window

When **Allocate…** is selected from the **Commands** menu, the allocation window appears. This allows you to control the details of the allocation procedure. The window is shown in Figure 24.

The parameters here control the various steps of the allocation. The default is to allocate the maximum number of targets and optionally leave a number of fibres for subsequent sky allocation.

- **Target selection** allows the selection of the allocation algorithm as described in the previous section on the allocation algorithm in detail.

- **Fibre uncrossing** controls aspects of the fibre uncrossing scheme. The default is to uncross at the end of the allocation, which will suffice for most fields. If there are many priority levels of object, one can sometimes gain in allocations by selecting uncrossing after each priority pass, though this is more time consuming. It is also possible to uncross existing configurations either here or by selecting **Uncross Fibres** in the **Commands** menu and then proceed to allocate extra objects without removing the existing allocations.

7.11 Sky Fibres

It is important to have sufficient sky fibres allocated.

You can supply sky positions in the input catalog – for example, positions which have been carefully checked on images to ensure absence of bright objects. To assign to these, make sure that you have suitable values set in the boxes in the allocation dialogue that allow you to specify the number of fibres of each type that are to be allocated to sky targets.

If you do not have sky positions in your input catalog, you should still use the same boxes in the allocation dialogue that allow you to specify the number of fibres of each type that are to be allocated to sky targets. If there are no sky targets at all in the target list, the specified number of fibres of each type will be left unallocated in the normal allocation process. You may then create a grid of sky positions and allocate these positions automatically by selecting **Allocate Sky Grid…** from the **Commands** menu.

Finally, arbitrary sky positions can be assigned interactively (see below).

It may be desirable to check the positioning of sky fibres that have been automatically allocated or added by hand, to ensure that these are not contaminated by stray objects, particularly brighter stars. This can be done by selecting **List…** from the **Commands** menu, and checking the **Allocated Sky as DSS input** button. This will list all allocated sky positions

as J2000 coordinates to a file (the default file name is the same as that of the input file, but with the extension **.dss**) which is in the correct format to be read by the commonly available StScI **getimage** program. The sky positions are named **S*nnn*** in the **.dss** file, where ***nnn*** is the fibre number. The content of the sky fibres can then be conveniently checked using a FITS aware visual browser (eg the visual schnauzer in **xv**). Alternatively, you can generate a list in SKYCAT format and look at the sky positions using SKYCAT.

7.12 Manual Allocation of Fibres

It is also possible to manually allocate individual fibres to objects. If you are using a priority scheme for allocating targets then you can highlight all allocated or unallocated targets within a given range of priorities using the **Highlight Targets…** option in the **View** menu.

Manual allocation is performed by interacting with the mimic display as follows:

- Select a fibre by clicking on its button – it will be highlighted in blue.
- Select an object by clicking on it – it will also be highlighted in orange.
- Select **Allocate Fibre** from the **Commands** menu.

The validity of the resulting configuration will be checked, and a progress dialogue will be displayed as this happens. If the resulting configuration is valid the allocation will be made and the display updated. If it is not valid, an error dialogue will appear.

There is a short cut in the manual allocation procedure that avoids the use of the menu as follows:

- Select a fibre by clicking on its button.
- Move the cursor over the desired object and click the middle mouse button.

It is possible to manually allocate fibres and then select **'uncross first then allocate extras'** in the allocation dialogue window to automatically assign the rest of the fibres while preserving the manual allocation. (This is an expert mode option)

It is also possible to deallocate fibres manually as follows:

- Select a fibre by clicking on its button. You need to position the cursor carefully to ensure you select the fibre rather than the object. Make sure the fibre button is highlighted in red. This operation is easier if the display is zoomed.
- Select **Deallocate Fibre** from the **Commands** menu.

Sky positions, either included in the input configuration file or generated as a sky grid, are allocated in the same way as objects. However, there is an additional facility that allows you to create an arbitrary sky position anywhere in the field. To do this, select a fibre in the normal way with the left mouse button. To assign it to a sky position use CTRL + middle mouse button. This creates a sky target in the configuration under the cursor and attempts to

assign a fibre to it and is most useful for assigning miscellaneous unallocated fibres to nominal sky positions.

7.13 The Mimic Display

The display can be zoomed to magnifications of 2,4, or 8 times its normal scale using the **Zoom** menu. The zoomed display can be scrolled using the scroll bars.

It is also possible to zoom the display by a factor of two about any selected point by clicking the right mouse button with the cursor positioned at the desired centre.

In the display, reference stars are shown as large red circles, target objects as small black circles and sky targets as blue squares. VLT guide stars are shown as large cyan circles. Fibre buttons are shown in different colours to distinguish between different fibre types. Disabled or non-existent fibres are shown in red. Highlighted objects and fibre buttons are shown in blue. Information about individual objects or fibres in the display can be examined by double clicking on the objects or fibre buttons.

The display can be printed by selecting the **Print…** command from the **File** menu. A postscript version of the mimic window will be generated which can either be sent directly to a printer or saved as a file, according to selections in the resulting dialogue box.

7.14 Saving a Configuration

After completing the allocation process and checking its validity, the resulting configuration can be saved as an SDS file by using **Save** or **Save as SDS…** from the **File** menu. The resulting SDS file is in a form suitable for use by the 2dF and 6dF observing systems.

It is also possible to save the configuration in ESO's PAF format, using the **Save as PAF…** option in the **File** menu.

A text file listing the fibre allocations and/or the unallocated objects can be obtained by selecting the **List…** option from the **File** menu.

7.15 Batch Mode

It is recommended that the configure program be run interactively. However, there is a limited feature for using it in batch mode. To make configure read in the input configuration file **filename.fld** and allocate it automatically, use the command:

```
configure -a -f filename.fld
```

(Note: the command to start configure may be different on your system.) This will produce two new files, **filename.sds** and **filename.**. The first can be fed back into the program in interactive mode to show how the fibres have been allocated. The second is a text file that contains details of the pivot allocation and can be processed by some other program to analyse the way the field has been configured).

7.16 Command Line Switches

The configuration program supports a number of command line options:

-a Invokes batch mode.

-f filename Specifies the initial input file.

-I instrument Specifies the instrument to be used. This is only useful if the program has been configured with support for a number of different instruments, in which case it eliminates the initial dialogue where configure asks you which instrument to use. For 2dF one would use –I 2dF.

-k Disables fibres which go to a particular spectrograph. (This option is under review at the moment.)

-p N Sets the initial plate.

There are also a number of options that can be used to perform specific actions when invoked with the –f option:

-i Specifies an ASCII file to read with a set of fibre number, fibre name pairs. This file will be used to perform a specific set of allocations *with no checks whatsoever*. It will then write an output file and exit.

-d Instructs configure to read in the .fld file, write out a .sds file with no allocations and then exit. This is useful if there are targets in the file that you wish to inspect with 2dF's focal plane imager.

-s Instructs configure to interpret the argument of the –f flag as a . sds file. This file is read in and an auto-reallocation pass is performed, followed by an additional allocation pass and an allocation of remaining fibres to the grid of sky positions. This option was introduced to 2dF for the Galaxy Redshift Survey.

8 Obtaining and installing the program

CONFIGURE can be obtained, from the AAO, via the web. The 2dF home page can be found under the address:

http://www.aao.gov.au/2df

and links on this page will lead you to CONFIGURE. CONFIGURE is distributed in the form of a binary file suitable for Solaris 2.6 (SunOS 5.6), Linux (built under Red Hat 7.1) or MacOS X, as a gzip'ed tar file. Create an empty directory and gunzip it, then un-tar it into the same directory. The directory will now contain the program itself, configure, together with a number of **.tcl** files it uses and a couple of additional files that provide details of the instrument configurations and bitmaps used by the program. It will also contain two sub-directories that contain the Tcl/Tk files needed to run CONFIGURE.

(Users should make sure they are running the latest version of the program. In particular, they should make sure they are using the latest version of the instrument status file they need: fpInsStatus.sd for FLAMES, tdFconstants.sds for 2dF, sixdFconstants.sdf for 6dF, since this has the most up to date configuration for the fibres – including details of any broken fibres. In addiiton, 2dF requires a number of astrometric files, tdFlinea0r.sds, tdFlinear1.sds, tdFdistortion0.sds and tdFdistortion1.sds. These exist in a number of different versions, suitable for different declination ranges. You should check that you have the latest versions of these, and that you are using the files appropriate to your declination range. These constants files are not included in the software distribution. These files must be separately downloaded from the AAO web site.)

The program is a straightforward tcl/tk program, which is why it is relatively easy to port to various different platforms. The main requirement is that tcl/tk should be available for the target platform.

9 The Menus in detail

This section describes the menu contents for the all the menus available in the main control panel – the File, View, Options, Commands, and Zoom menus. All the features of the program are available through these menus. Note that there are additional menu items available if the program is run in 'expert' mode. These are shown in the next section. Note also that the menu items vary slightly depending on which instrument is being configured. The menus shown here are those seen when 2dF or 6dF are in use.

9.1 The File menu

Figure 2 shows the File menu. Note that this is shown when the configuration program is being used to configure 2dF or 6dF. For FLAMES, PAF file format is the default rather than SDS, and this is reflected in the menu options.

Figure 2 The file menu

Open	Puts up a file selection dialogue to read in a new list of targets from a text input file (usually a .fld file). If a file is already open and has not yet been saved, you will be asked if you want to save it before opening the new file.
Open SDS	Puts up a file selection dialogue to open an SDSformat file (usually a file saved as the result of a previous run of CONFIGURE). This will put the program back to the state it was in when that file was saved, at least so far as fibre allocations are concerned. If a file is already open and has not yet been saved, you will be asked if you want to save it before opening the new file.

Save as SDS File	Puts up a file selection dialogue allowing you to save the details of the current configuration in SDS format.
List…	Puts up a dialogue box allowing you to specify what details should be included in the list file to be created, and then puts up a file selection dialogue box to allow you to specify the name of the list file. This can be used to generate catalogues that can be read by Skycat.
Print…	Creates a printed version of the mimic display window.
Exit	Exits the program.

9.2 The View menu

Figure 3 shows the View menu.

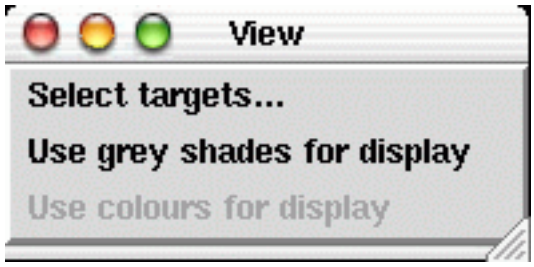

Figure 3 The view menu

Select Targets	Puts up a dialogue that allows you to highlight target objects of different types. For example, you can choose to highlight targets in a given priority range, or targets that are classified as sky targets. Highlighting is quite subtle and if there are a large number of targets even a highlit target may not show up sufficiently. So this dialogue also allows you to redraw the mimic display with all targets magnified. It also has an option that indicates all highlit targets with large blue arrows – the result is unsubtle, but quite obvious.
Use grey shades for display	Switches from using colours to differentiate between fibre types to using different shades of grey. Some users find it easier to distinguish shades of grey rather than colours. This option is only active if grey shades are not already being used.
Use colours for display	Switches from using different shades of grey to differentiate between fibre types and using colours. Most users find it easier to distinguish colours rather than shades of grey. This option is only active if colours are not already being used.

9.3 The Options Menu

Figure 4 shows the Options menu.

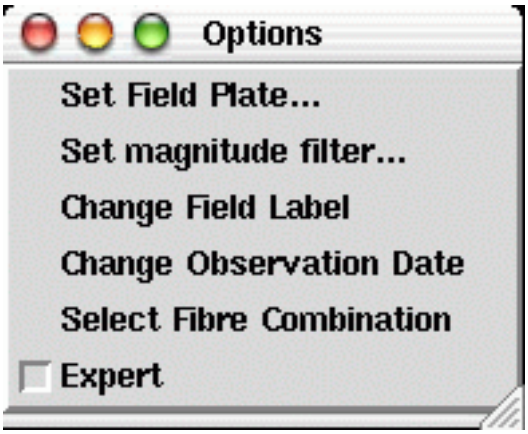

Figure 4 Options menu

The options menu provides control over a number of possible options for the program.

Set magnitude filter…	Puts up a dialogue box that allows you to change the magnitude range used to filter the input target list.
Change Field Label	Allows the label for the field to be changed.
Change Observation Date	Allows the date of the observation to be changed. This may invalidate any existing configuration, and so if fibres have already been allocated the configuration should be checked using the **Check Allocation** option in the **Commands** menu.
Select Fibre Combination	Puts up a menu showing all the fibre combinations supported by the instrument, allowing one such combination to be specified for use when fibres are allocated. This allows the same input configuration file to be used to generate a number of different configurations depending on which instruments are in use.
Expert	Allows the program to be set into ‘expert’ mode. This makes available a number of additional features, described in detail in the next section. The check box next to this option is filled if ‘expert’ mode is already selected. (And there are more options shown in expert mode.)

9.4 The Commands Menu

Figure 5 shows the Commands menu.

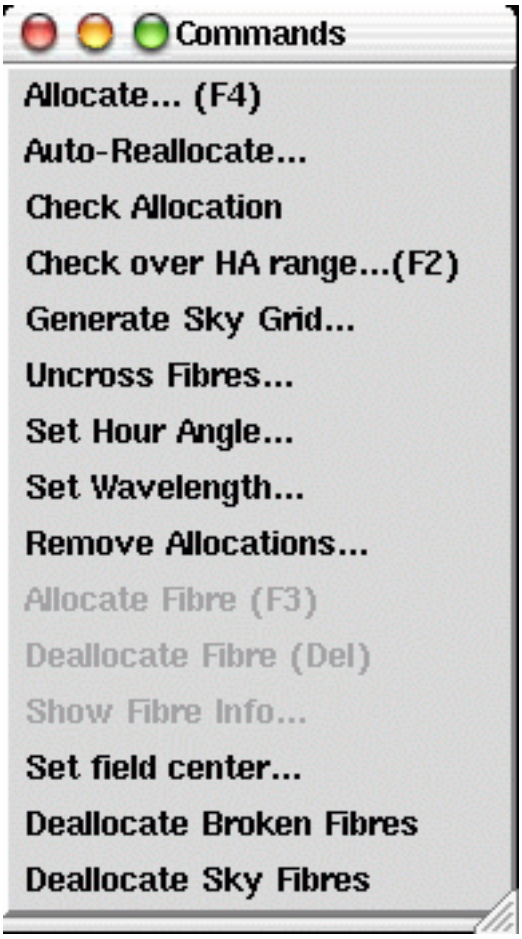

Figure 5 The commands menu

The Commands menu allows you to invoke most of the operations that CONFIGURE can perform.

Allocate	Performs a complete fibre allocation. It puts up the allocation dialogue that allows you to modify the parameters used by the allocation algorithm, and then starts the allocation process.
Auto-reallocate	Invokes the allocation algorithm in a mode where it modifies the current allocation to allow for broken fibres. This is useful when an existing allocation has been read in from an SDS file but the instrument setup has changed since the allocation was made.
Check Allocation	Performs a validity check on the current allocation. This is useful when an existing allocation may have become invalid – for example, because the observation time has been modified.
Check Over HA range	Puts up a dialogue allowing you to check the current allocation over a range of dates and hour angles.
Allocate Sky Grid	Automatically allocates a grid of sky targets. This is an alternative to providing a specific set of sky targets in the input target file, but of course the program has no way of knowing

	what parts of the target field are really clear and suitable for use as sky.
Uncross Fibres	Invokes the allocation algorithm in a mode that merely attempts to exchange fibre/target allocations in such a way as to mimimise the number of fibre crossings.
Set Hour Angle	Puts up a dialogue box allowing you to specify the hour angle for the observation. After a change such as this you should check the validity of the allocation (if there is one) using Check Allocation.
Set Wavelength	Puts up a dialogue box allowing you to specify the central wavelength for the observation in angstroms. This will change the plate positions of the various targets very slightly, and should check the validity of the allocation (if there is one) using Check Allocation.
Remove Allocations	Removes all the current fibre/target allocations, if any. A dialogue box is put up asking you to confirm that you want this doing.
Allocate fibre	This is only active if a fibre has been selected (by clicking on in the mimic display) and a target has been selected (also by clicking on in the mimic display). It causes that fibre/target allocation to be made and verified. This can be useful as a check on why the algorithm did not make what appears to be an obvious allocation – select the fibre and target in question and use this option to allocate them explicitly. You will often get an error message explaining why the allocation cannot be made.
Deallocate fibre	Only active if a fibre has been selected (by clicking on it in the mimic display). If the selected fibre has been allocated to a target, this causes it to be deallocated and returned to its park position.
Show fibre info	Only active if a fibre has been selected (by clicking on it in the mimic display). Puts up a window giving details about the fibre.
Set field center	Moves the field center so that the field is now centered at the place last clicked on the mimic display. So the idea is that you click on the mimic display at the required field center, then select this menu option. You will see a dialogue box asking you to confirm this change. This change will invalidate any current configuration.
Deallocate Broken Fibres	Removes any allocations that involve broken fibres. You can only get such an allocation by reading in a configuration (from an SDS or PAF file) that was made with a different instrumental setup file.
Deallocate Sky Fibres	Removes any allocations that involve sky targets. (The name of the menu item is a little misleading – it is the target that is sky,

rather than the fibre, although it is true, for example, that all ARGUS fibres are sky fibres.)

9.5 The Zoom menu

Figure 6 shows the Zoom menu.

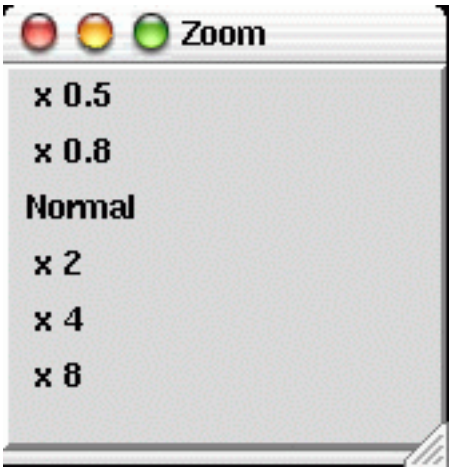

Figure 6 The zoom menu

This menu permits you to select a display according to a range of scale factors. You can reduce the image size, as well as expand it from the usual size. The zoom menu just presents a set of 6 zoom values that are generally useful. More extreme values can be obtained by right-clicking in the mimic display. (Note that there is no dialogue that allows a completely arbitrary zoom factor to be specified.)

1 Expert Mode

CONFIGURE has an 'expert' mode. It provides a number of additional menu items, additional options in dialogues (particularly the allocation dialogue), and removes a number of restrictions.

1.1 Invoking expert mode

Expert mode is invoked through an 'Expert mode' item in the 'Options' menu. This is a toggle that takes the program in and out of expert mode.

1.2 Menus in expert mode

This section shows all the control panel menus as they appear when expert mode is selected. In expert mode, new options appear at the bottom of all the menus (except for zoom, which is unchanged in expert mode). This section only provides explanations for those items that are unique to expert mode.

1.2.1 The File menu in expert mode

Figure 7 shows the File menu in expert mode. Note that this is shown when the configuration program is being used to configure FLAMES. For other instruments, SDS file format is the default rather than PAF, and this is reflected in the menu options.

Figure 7 The File menu in expert mode

The additional options that are available in expert mode are:

Open PAF	Puts up a file selection dialogue to open an PAF format file (usually a file saved as the result of a previous run of FPOSS). This will put the program back to the state it was in when that file was saved. If a file is already open and has not yet been saved, you will be asked if you want to save it before opening the new file.
Merge…	Puts up a dialogue that allows you to specify the name of an existing SDS format file (usually one saved during a previous run of the configuration program). The lists of unallocated targets in the current configuration (both guide and non-guide targets) are replaced by those in the specified file.
Save (^S)	Puts up a file selection dialogue that allows you to save the current configuration a file in the default format for the instrument. So if the program is producing configurations for FLAMES the save will be to a PAF format file. If 2dF or 6dF is not being used the save will be to a file in SDS format.
Save as PAF file	Puts up a file selection dialogue that allows you to save the current configuration as a PAF format file. This is the default

	file format used when configuring the ESO FLAMES instrument.
Save Alloc to UnAlloc	This command is used to prepare a currently configured field for reconfiguration on the other plate. It copies the list of allocated targets into a new file as a list of unallocated targets. Configuring using this new file will ensure that only those targets originally configured will participate in the new configuration for the new plate.

1.2.2 The View menu in expert mode

Figure 8 shows the View menu in expert mode.

Figure 8 The View menu in expert mode

The additional options that are available in the view menu in expert mode are:

Show empty fibre positions	In the mimic display, only fibres that are directly participating in the current configuration are normally shown. In additon, there are a number of fibre positions that are given numbers, but do not actually have fibres. These are also usually not shown. If ‘show empty fibre positions’ is selected, all fibres (even those that are only placeholders for non-existent fibres) are shown in the display. This option is only active if empty fibre positions are not being shown.
Hide empty fibre positions	Reverts to the default mode where only only fibres that are directly participating in the current configuration are shown in the mimic display. This option is only active if empty fibre positions are being shown.

1.2.3 The Options menu in expert mode

Figure 9 shows the Options menu in expert mode.

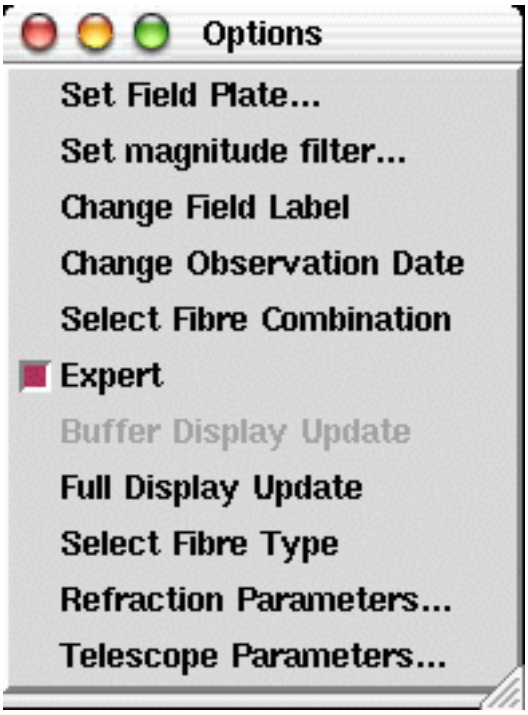

Figure 9 The Options menu in expert mode

The additional options that are available in the options menu in expert mode are:

Buffer Display Update	Puts the program into a mode where changes to the mimic display are buffered and applied only when the buffer is full. This makes the program run faster, but at the expense of a rather jerky display. In practice, the buffering code has changed recently and there is now little difference between the two buffering modes.
Full Display Update	Puts the program into a mode where changes to the mimic display are applied as soon as the underlying configuration changes. This makes the program display smoothly, but at the expense of some additional execution time, particularly on X-terminals. In practice, the buffering code has changed recently and there is now little difference between the two buffering modes
Select Fibre Type	Puts up a dialogue that allows the various fibre types to be selected independently. This allows non-standard fibre combinations to be selected, and so should normally be avoided. This is the only way to create a configuration that uses test fibres.
Refraction parameters	Puts up a dialogue that allows the refraction parameters built into the astrometric model to be modified.

Telescope Parameters	Puts up a dialogue that allows the telescope parameters built into the astrometric model to be modified.

1.2.4 The Commands menu in expert mode

Figure 10 shows the Commands menu in expert mode.

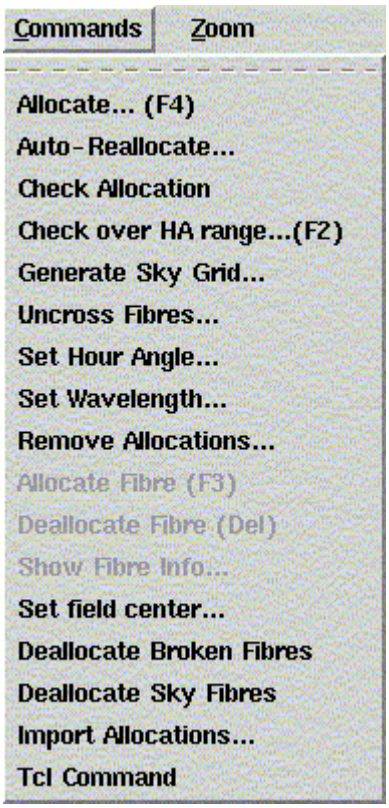

Figure 10 The Commands menu in expert mode

The additional options that are available in the commands menu in expert mode are:

Import allocations	Puts up a dialogue allowing you to select a file that contains a list of fibre/target allocations and apply those.
Tcl command	Puts up a dialogue that allows direct Tcl commands to be entered. This is a very powerful facility, but needs intimate knowledge of the program's internal structure and Tcl code to be useful. Anyone without such knowledge should avoid this command. Anyone with such knowledge will already know to avoid using this command. (It is mostly for the convenience of program developers, allowing features to be exercised for which no GUI control is available yet.)

1.3 The Allocation Dialogue in Expert mode

When the program is running in expert mode, a number of additional options are available in the allocation dialogue. The expert mode allocation dialogue for the simulated annealing algorithm is shown below in Figure 12.

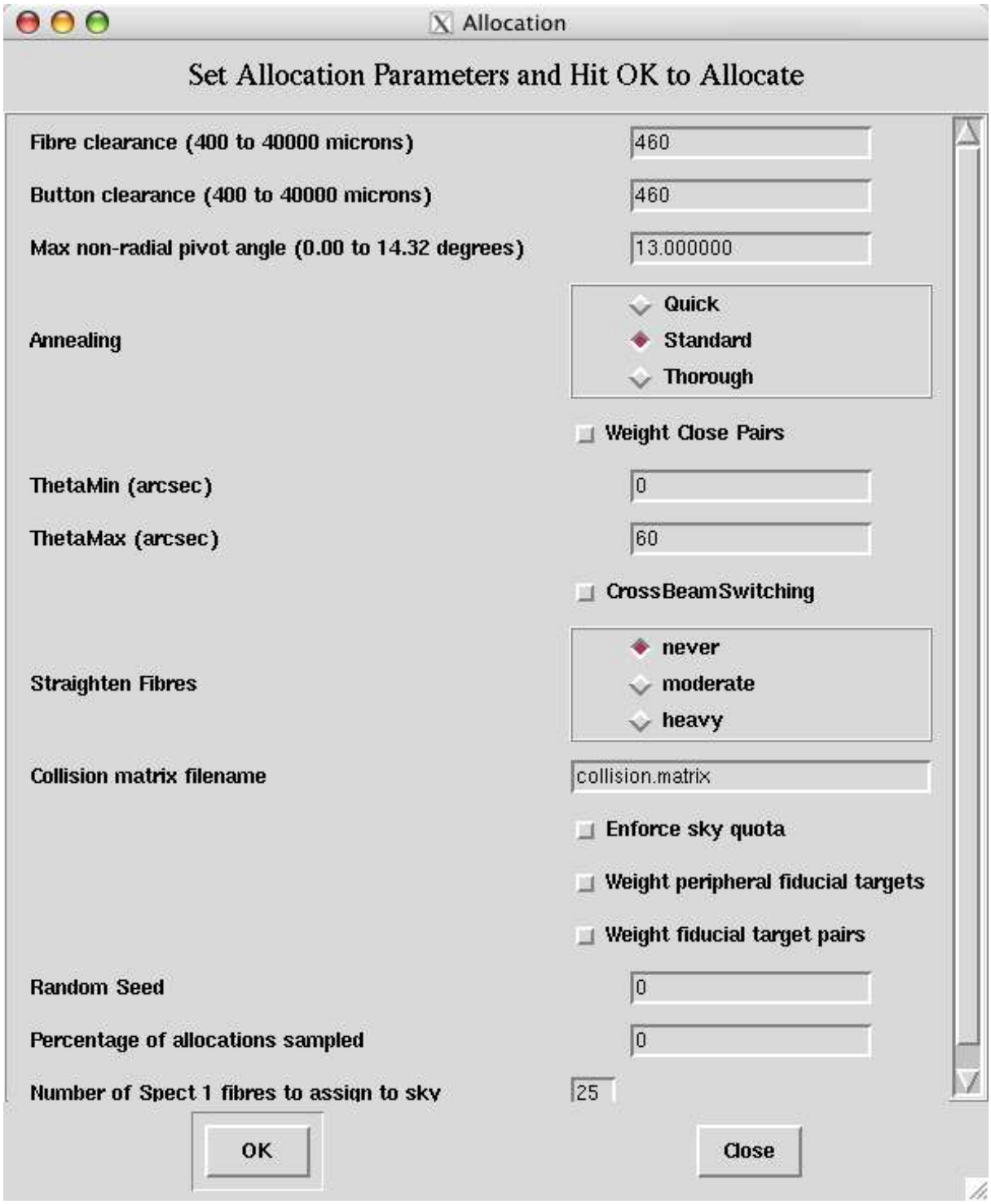

Figure 11 Annealing allocation dialogue in expert mode

The clearance parameters shown here are the same as for the traditional algorithm, described next.

The '**random seed**' allows a specific seed to be specified for the random number generator used by the annealing algorithm. Zero means that the seed will be different each time the program is run, and so the results will differ slightly. By selecting the same seed for each allocation, exactly the same results should be obtained. This is used mainly for debugging purposes, where it is sometimes important to be able to reproduce conditions in the code exactly in order to trigger an obscure problem.

The '**percentage of allocations sampled**' is used to invoke the sparse sampling algorithm described in section 7.8.1.1. Zero (the default) indicates that no sampling of the set of possible allocations is performed. Setting this to a non-zero value causes the algorithm to try to reduce the total number of allocations it considers in the annealing stage in order to reduce the CPU and memory requirements of the algorithm.

If the traditional algorithms (in the 'configureTrad' executable) are being used, the expert allocation algorithm looks as below. Note that the allocation dialogue now has so many options that on some screens it needs to be scrolled. It is shown here as a single screen without scrolling.

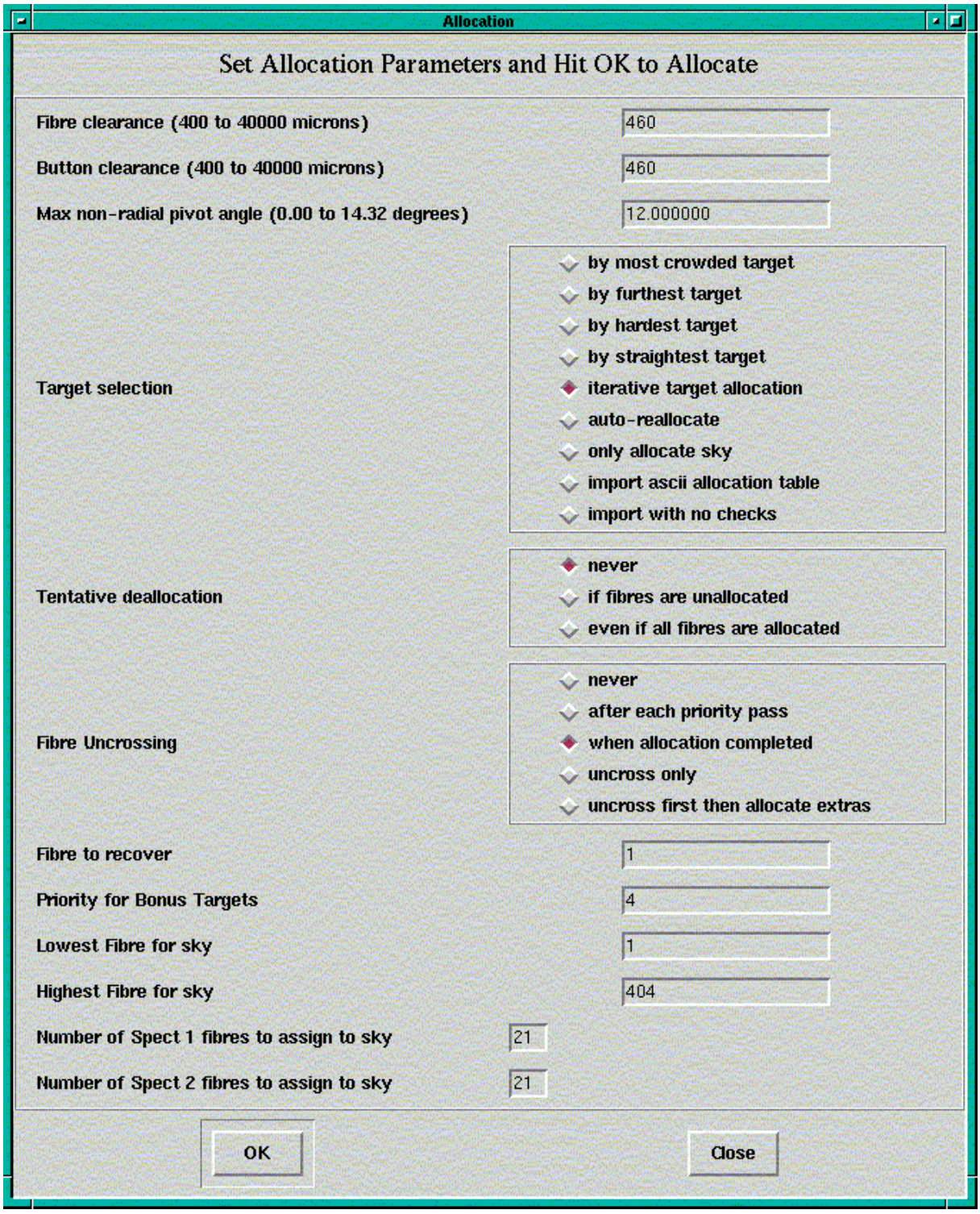

Figure 12 The Allocate dialogue in expert mode

This shows the clearance parameters used by the program. Note that in the interests of producing configurations that are likely to be valid over a range of hour angles, CONFIGURE uses clearance parameters that are more constraining that those used by the actual positioner. You can change the clearance parameters, but only to the limiting values actually used by the positioner.

The fibre clearance gives the number of microns that must be left clear each side of a fibre. The button clearance gives the number of microns that must be left clear around a button. Decreasing these will give the program more leeway to allocate fibres, but means that you will need to be reasonably certain of the hour angle at which you intend to observe.

Note that if more than one spectrograph is in use at once it is important to make sure that enough sky fibres are allocated to each. This information can be obtained from the **Select Targets…** option in the **View** menu.

Fibre to recover is an option that can be used explicitly to reallocate a specific fibre that was originally allocated in a way that has been deemed to be invalid.

Priority for bonus targets is used only when the program operates in auto-reallocate mode. In this mode, it attempts to re-allocate any fibres that were originally allocated in a way now deemed invalid. It will treat any target with a priority less or equal to that specified as a ‘bonus’ target which can be discarded without serious loss in order to allocate the free fibres to higher priority targets.

Lowest Fibre for Sky, Highest Fibre for Sky are used to limit the range of fibres that may be allocated to sky positions during the automatic allocation phase. This could be useful for example, if you wanted to ensure that all of your sky positions were recorded on the centre of the CCD chips. The "only allocate sky" option ignores these values.

10 Appendix A: A tour of CONFIGURE

You should try this out using the test configuration file supplied with the program. A number of test files are supplied with the configuration. For your first tour through the program, you should use the supplied file 2dF_Test_1.fld. This is a fairly typical input file. This section may seem quite long, but that is mainly because it has a lot of screen shots in it. Actually running through the tour should only take a few minutes.

10.1 Starting up

The configuration program is invoked in the same way as any UNIX program, by typing its path name and appending any necessary parameters. If the configuration program is in the user's default directory, all that is required is the command:

./configure &

(The ./ prefix is needed because security-conscious users will not have the default directory in their path, and the final & is because it is usually most convenient to run the program in the background.)

On AAO systems, typically the command "2dfsoftware" will create aliases for various 2dF software, including configure. This means that configure can be started with the simple command "configure" from any desired directory.

When the program starts up, it displays an initial window allowing you to specify the instrument to be used.

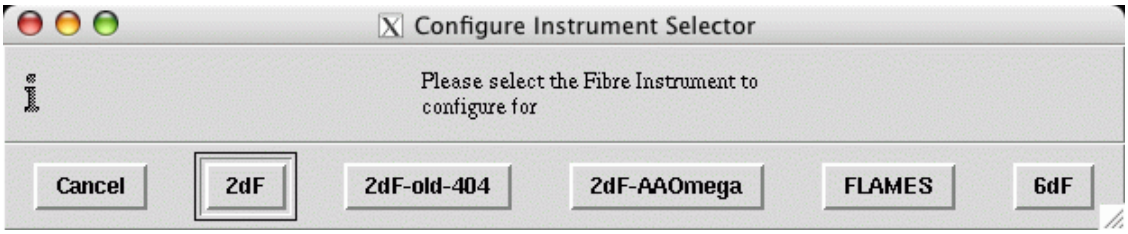

Figure 13 Instrument selection dialogue

For the purposes of this demonstration, we assume you select 2dF. If you select 6dF things are more or less the same, except for the details of the number of fibres and their location on the plate. If you want to configure for the ESO FLAMES instrument, things are significantly different (the program needs you to specify a VLT guide star, and there are complex issues connected with the number of different fibre types available with FLAMES). Configure is usually built specially for FLAMES, in a version known as FPOSS, that only supports FLAMES and which as its own version of this manual.

Click on the 2dF button. The program will configure itself for 2dF, and will display three windows. There will be a main control panel (Figure 15) and a window that will eventually show a 'mimic' display of the field plate with targets and fibres. Initially, this will just show a

number of concentric circles of varying radii (Figure 16). There will also be a 'basic sequence' window that is intended to guide you through the program (Figure 14).

Let's take a quick look at each of these windows, although at the moment they aren't very interesting.

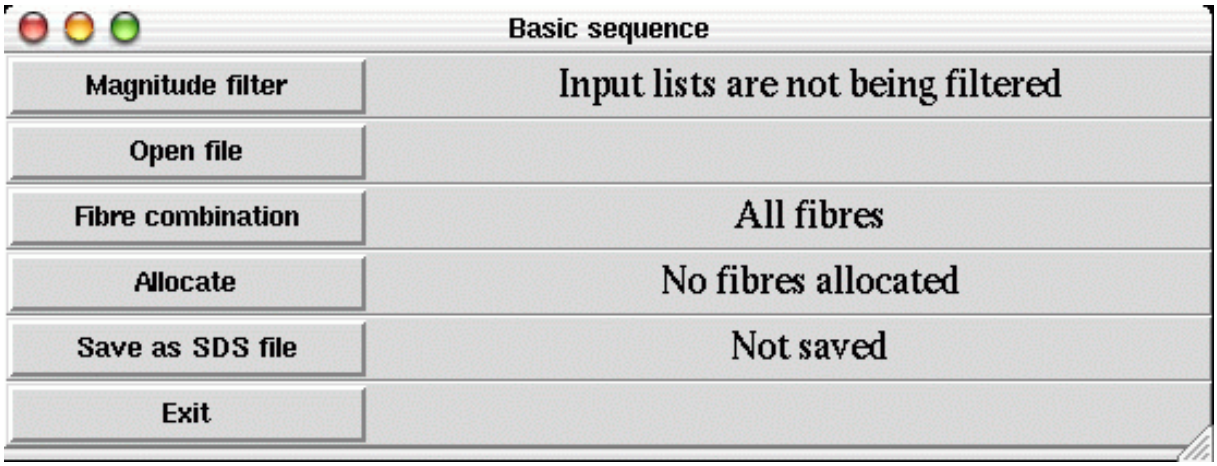

Figure 14 The Basic Sequence Window

For straightforward use of CONFIGURE, you will be able to control the configuration process almost entirely from the basic sequence window. The idea is that you press each of the buttons down the left hand side of the window in sequence. That is what we will do first in this tour of the program. Later we will look at some of the other options, using the menus in the main control panel..

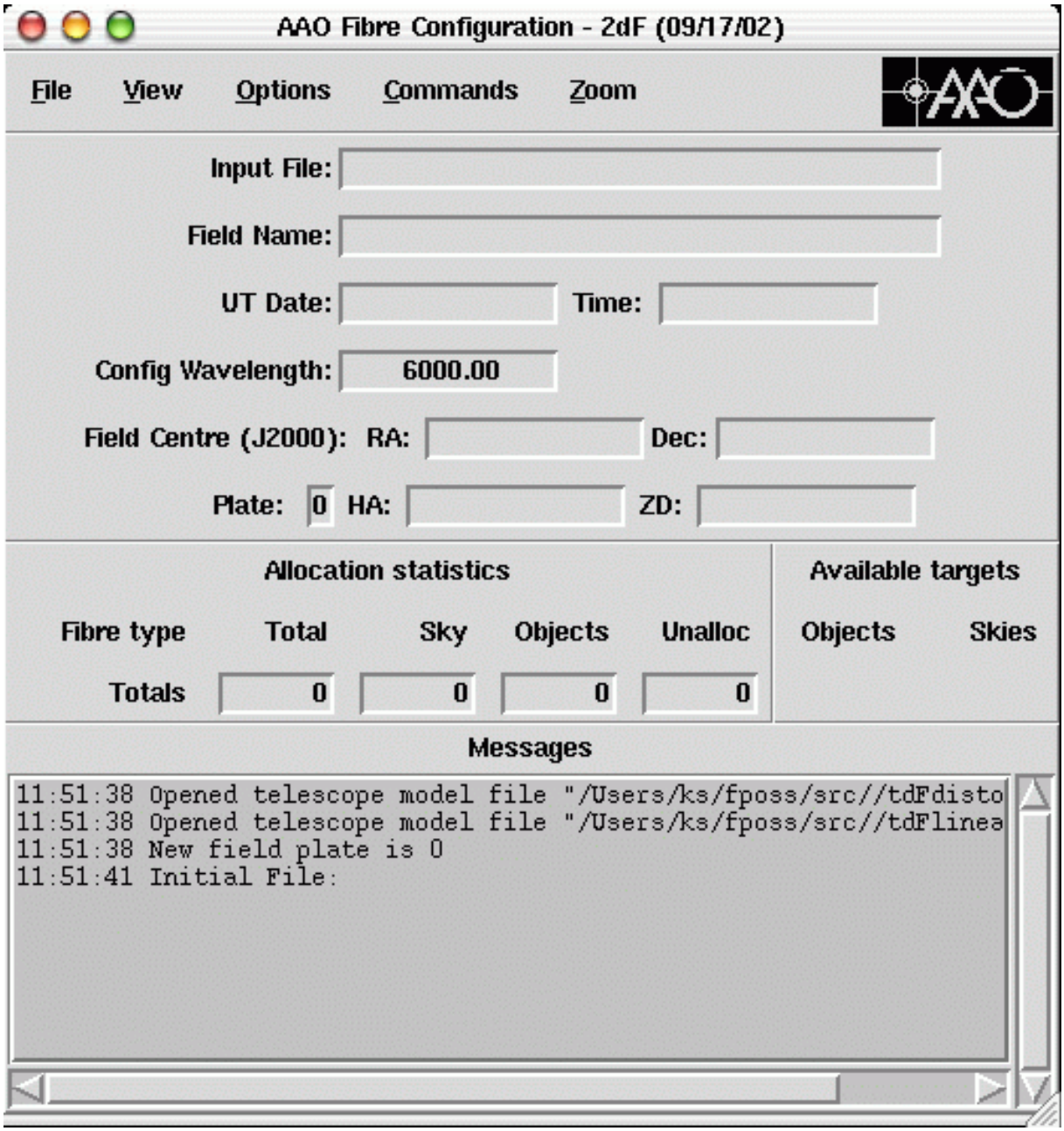

Figure 15 The control panel

The control panel contains a number of menus, and a large number of fields where information can be displayed, together with a scrolling region at the bottom for messages. Note that the fields are not editable, even though they might look like it.

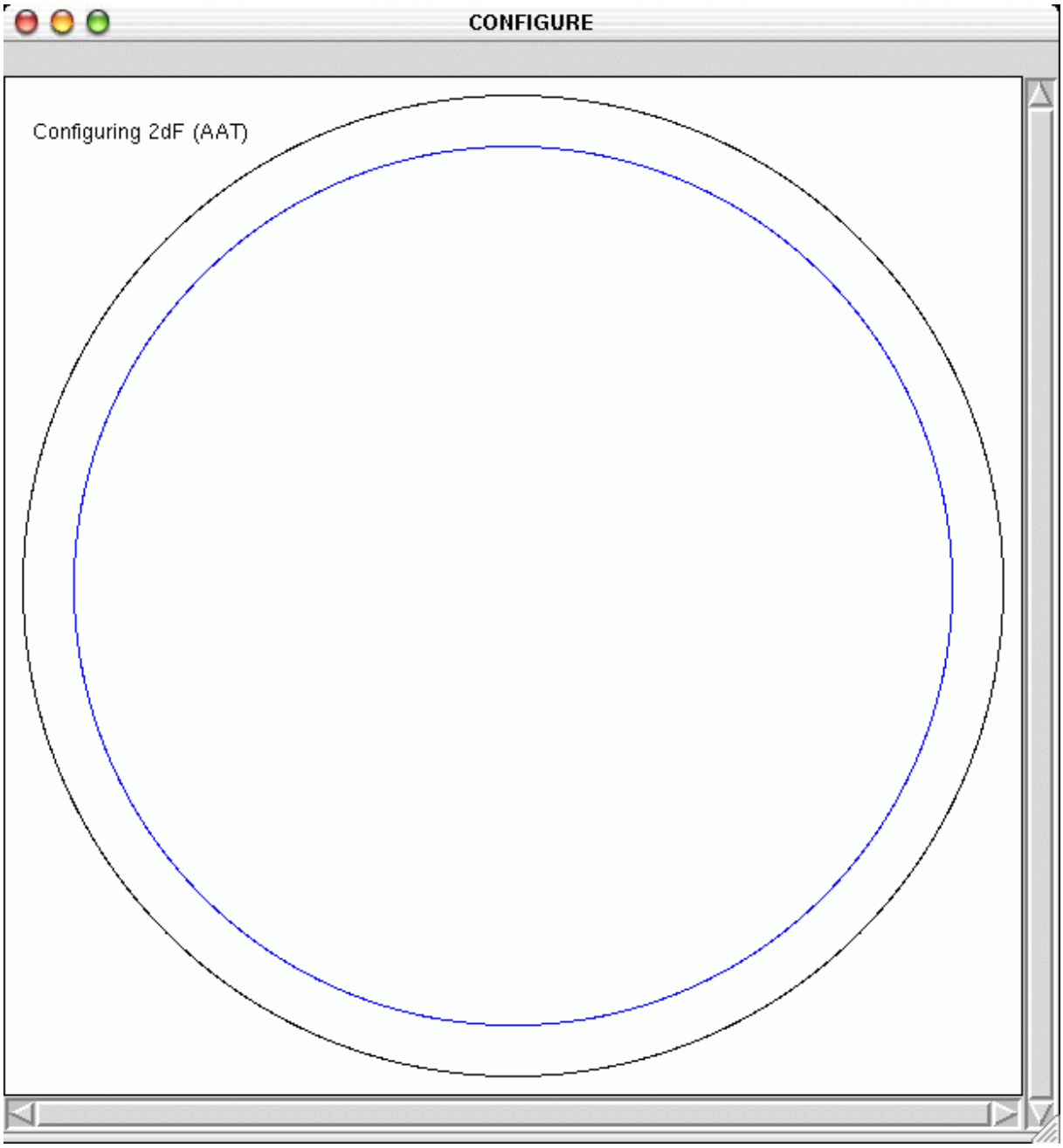

Figure 16 The initial mimic display

The mimic display at present only shows two concentric circles. If you move the cursor over these, the left part of the status bar at the top of the window will tell you what they are. The blue circle marks the furthest out that a fibre can be placed. The black circle marks the pivot circle – the point where the fibres emerge from their retractors around the field plate

10.2 Setting a magnitude filter

For files that have a large number of targets you will probably want to set a magnitude filter to reduce the number of targets to a manageable number. This is not true of the 2dF_Test_1.fld test file, and traditionally is not true of most 2dF fields. (It is a feature that was introduced mainly for the ESO FLAMES instrument.) However, you may as well see what it looks like.

This is where we start out through the basic sequence window. Click on the ‘magnitude filter’ button. You will see a dialogue prompting you to set a magnitude filter range.

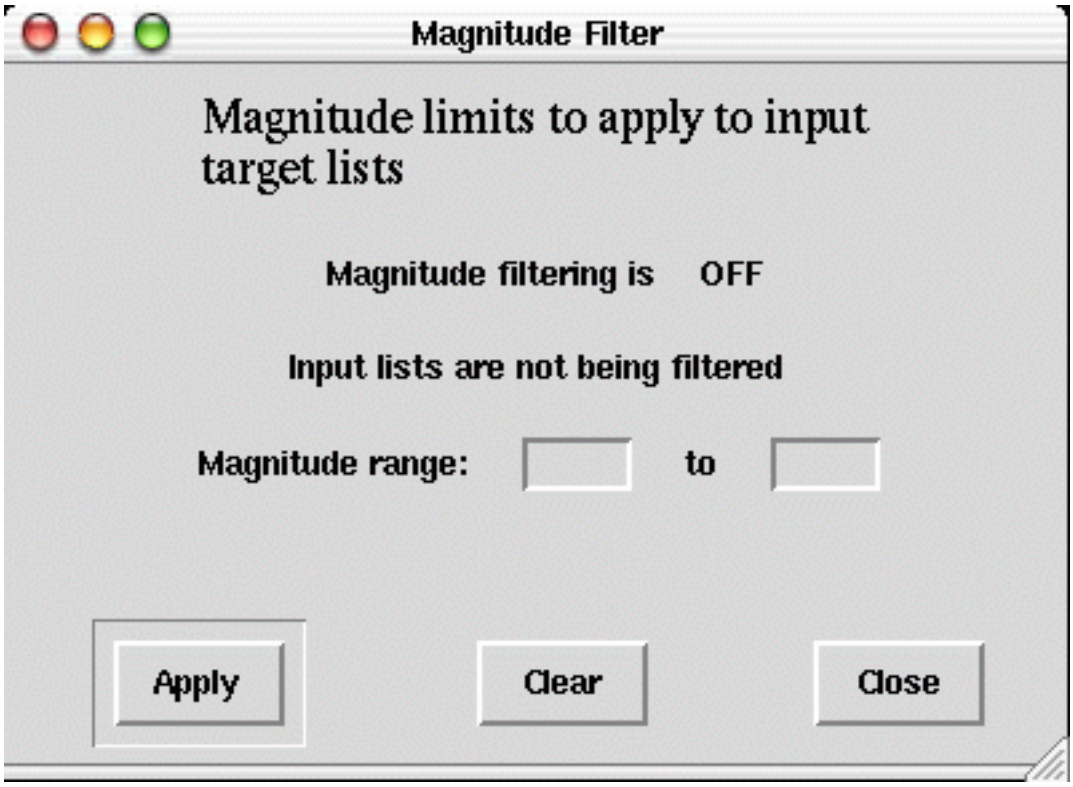

Figure 17 Magnitude filter dialogue box

If you do want to set a filter, fill in the two entry boxes and click on the ‘Apply’ button. Once you do that, the dialogue box changes to indicate the new settings. For the purposes of our demonstration, you can just click the ‘Close’ button.

10.3 Opening the data file

Now click on the ‘Open File’ button in the basic sequence window. This will bring up a file selection dialogue box. This will look something like this, depending on what files you have in your directory:

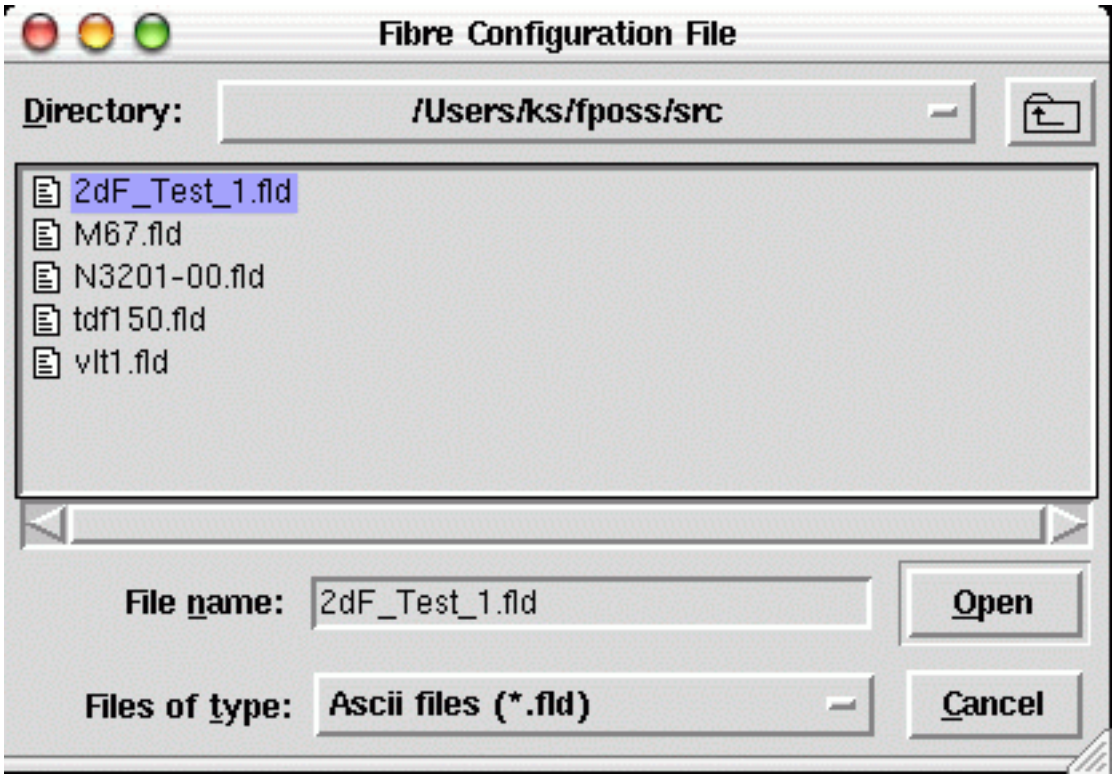

Figure 18 Open file selection

Select 2dF_Test_1.fld and click on the Open button. Now things start to happen. The target list in this file will be read in, optionally filtered by magnitude, and the program now has something to display on the mimic window. You will also notice that there is information at last in the various fields of the main control panel.

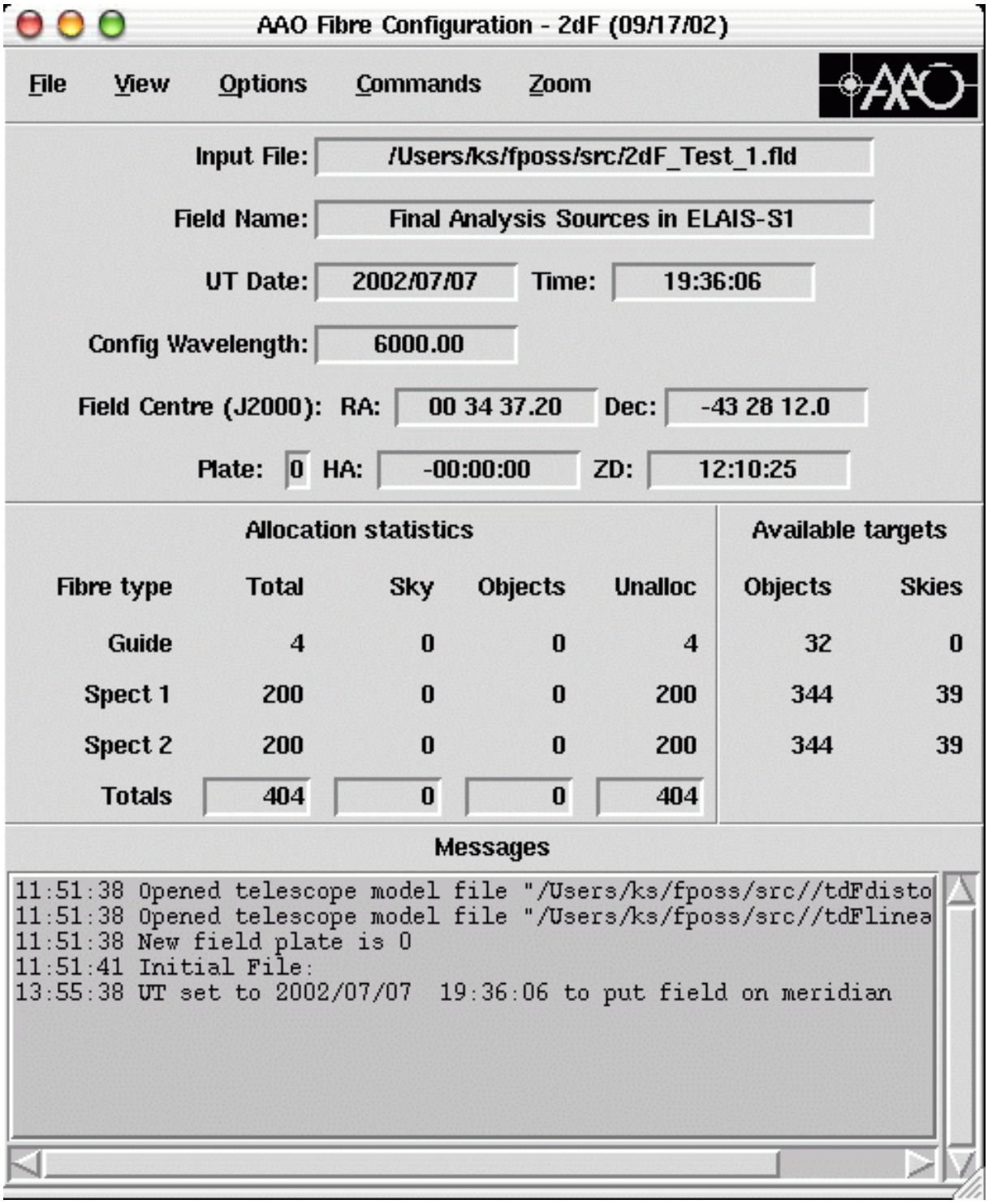
AAO Fibre Configuration - 2dF (09/17/02)
File
View
Options
Commands
Zoom
Input File: /Users/ks/fposs/src/2dF_Test_1.fld
Field Name: Final Analysis Sources in ELAIS-S1
UT Date: 2002/07/07 Time: 19:36:06
Config Wavelength: 6000.00
Field Centre (J2000): RA: 00 34 37.20 Dec: -43 28 12.0
Plate: 0 HA: -00:00:00 ZD: 12:10:25
Allocation statistics
Available targets
Fibre type Total Sky Objects Unalloc Objects Skies
Guide 4 0 0 4 32 0
Spect 1 200 0 0 200 344 39
Spect 2 200 0 0 200 344 39
Totals 404 0 0 404
Messages
11:51:38 Opened telescope model file "/Users/ks/fposs/src//tdFdisto
11:51:38 Opened telescope model file "/Users/ks/fposs/src//tdFlinea
11:51:38 New field plate is 0
11:51:41 Initial File:
13:55:38 UT set to 2002/07/07 19:36:06 to put field on meridian

Figure 19 Control panel with file open

As shown above in Figure 19, the details of the field are now displayed in the main panel, which will now show the number of targets, classified into ‘objects’, and ‘skies’ ‘Sky’ targets are any targets designated as sky, while ‘objects’ are anything else. Note that the available targets section shows the number of targets that can be allocated to each type of fibre. Since most program targets can be allocated to either spectrograph, you can tell that in the example shown above there are actually 344 target objects, 39 sky target objects, and 32 possible guide targets.

The above screen shot is now somewhat out of date. With the advent of the simulated annealing algorithm, the allocation statistics portion of the panel now looks like this:

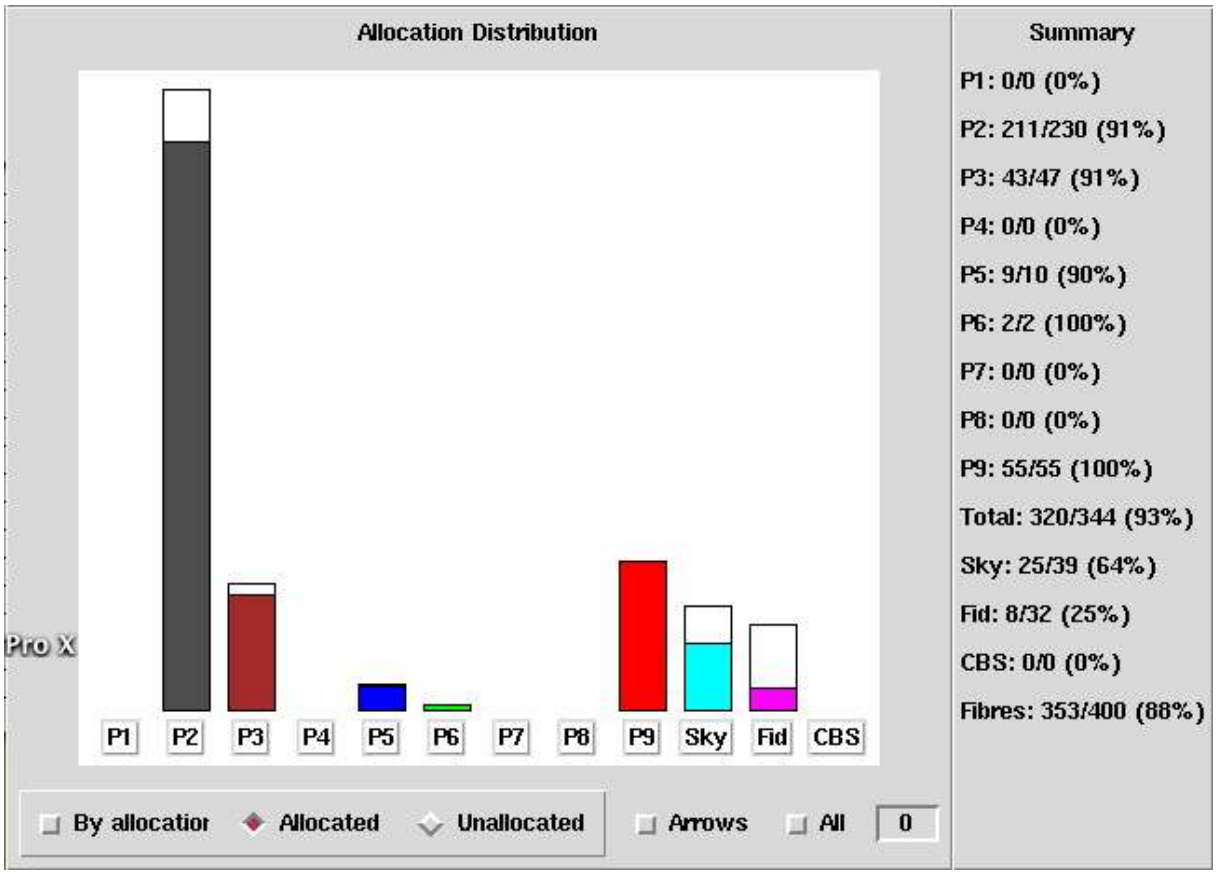

Figure 20 The new allocation statistics panel

This panel shows the distribution of the allocated fibres by priority. (Note that although sky and guide targets – the 'fid' column indicates fiducial, ie guide targets – do have a priority, they are treated separately here. The P1 through P9 columns only show program objects. CBS refers to cross-beam switching targetpairs, of which the field shown here has none.) The button-like labels beneath the columns actually are buttons. If these are clicked, the corresponding targets are highlit in the mimic display. If the 'by allocation' box is selected, then only those targets that match the selected allocation state (allocated or unallocated) are highlit. The 'arrows' check box causes arrows to be drawn indicating each selected target – this is sometimes useful in crowded fields.

Now that a configuration file has been read in, the targets are displayed in the mimic window, and the fibre positions are drawn, as shown in Figure 21. Since no fibres are allocated as yet, all the fibres are shown at their park positions, just inside the black circle on the mimic display. A compass at the top-right of the display shows the East and North directions, and the instrument is displayed in the top left corner. The orientation of the display is the default orientation, with East to the top and North to the right.

The guide fibres are shown in green and the spectrograph fibres are shown in light blue for spectrograph 2 and yellow for spectrograph 2. Broken fibres are shown in red. If you place the

cursor on top of a fibre the fibre type, including the spectrograph to which it is connected, is displayed in the top information bar of the mimic panel.

Note that other features of the mimic display, such as the meaning of the circles, are identified in the same way by moving the cursor upon them. The information appears in the top information bar.

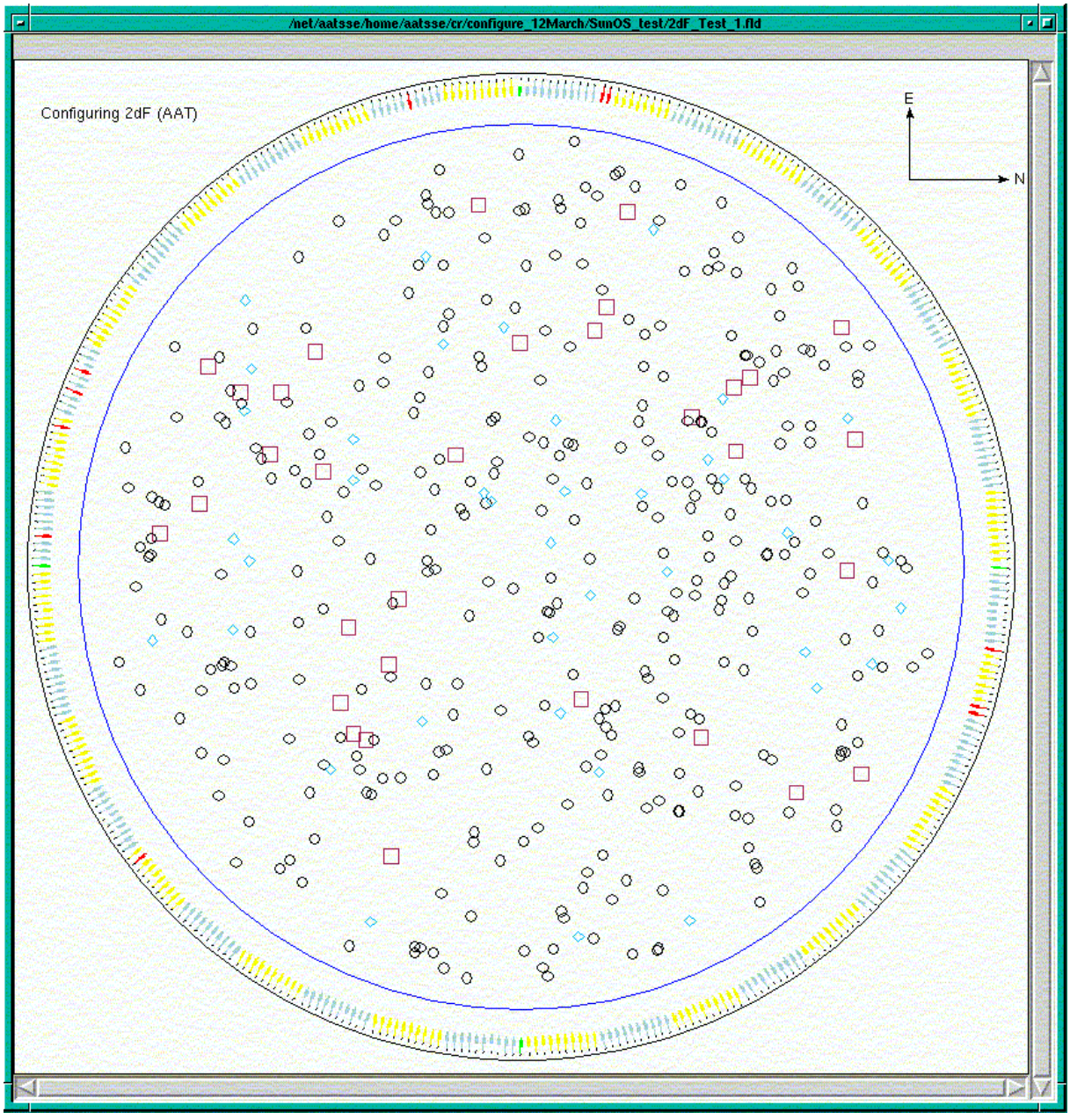

Figure 21 Mimic display with new field

10.4 Selecting the Fibre combination

By default, all fibre types will be included in the configuration. However, you can control this if you want to. Click on the 'Fibre combination' button in the basic sequence window, and the following dialogue will appear:

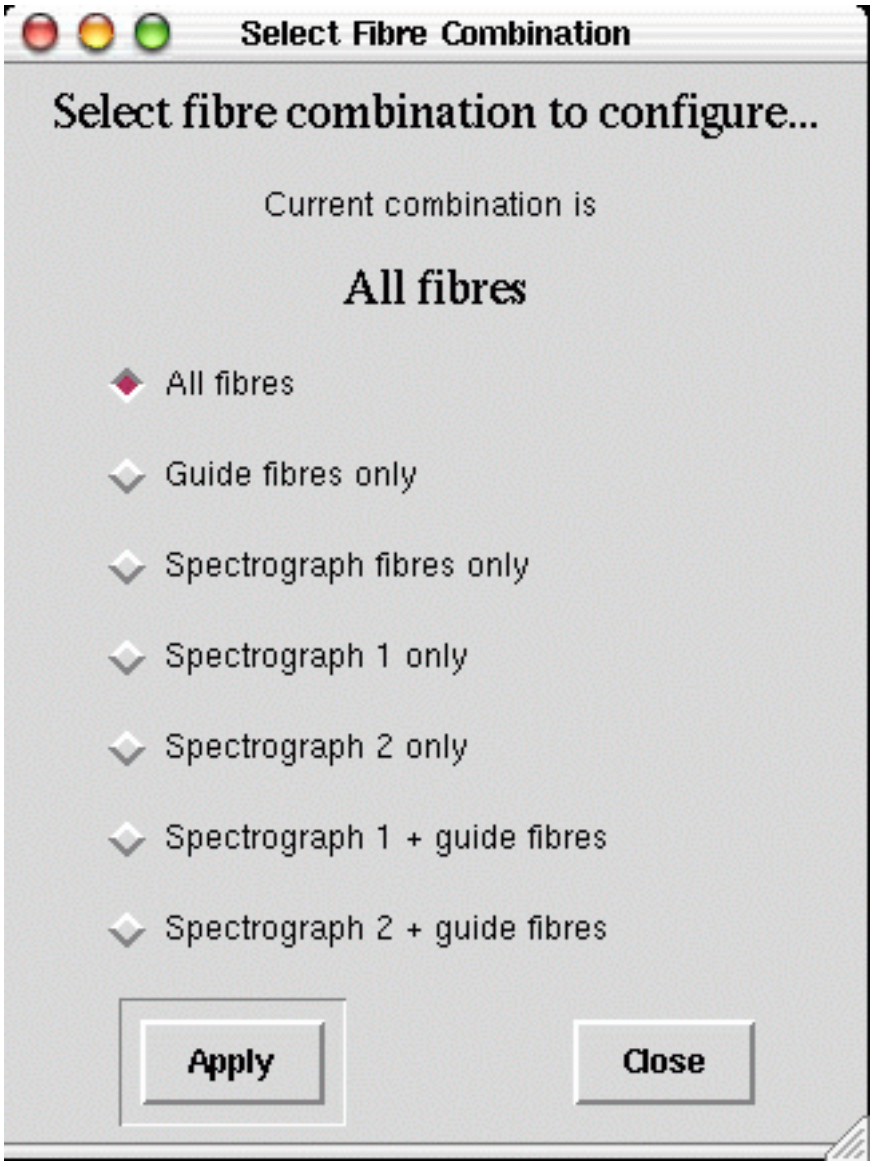

Figure 22 Fibre combination dialogue

You can select one of the allowed combinations. For the moment, just leave the combination set to 'all fibres' and press the 'close' button.

If you do change the fibre combination, the mimic display will change once you hit the 'apply' button. All the fibres except for those of the type selected are removed from the display, and the fibre colours change.

Now, we are in a position to allocate fibres to targets

10.5 Performing the Allocation

Click on the 'Allocate' button in the basic sequence window. You will get a dialogue box that presents you with a number of options that can be used to control the details of the allocation algorithm.

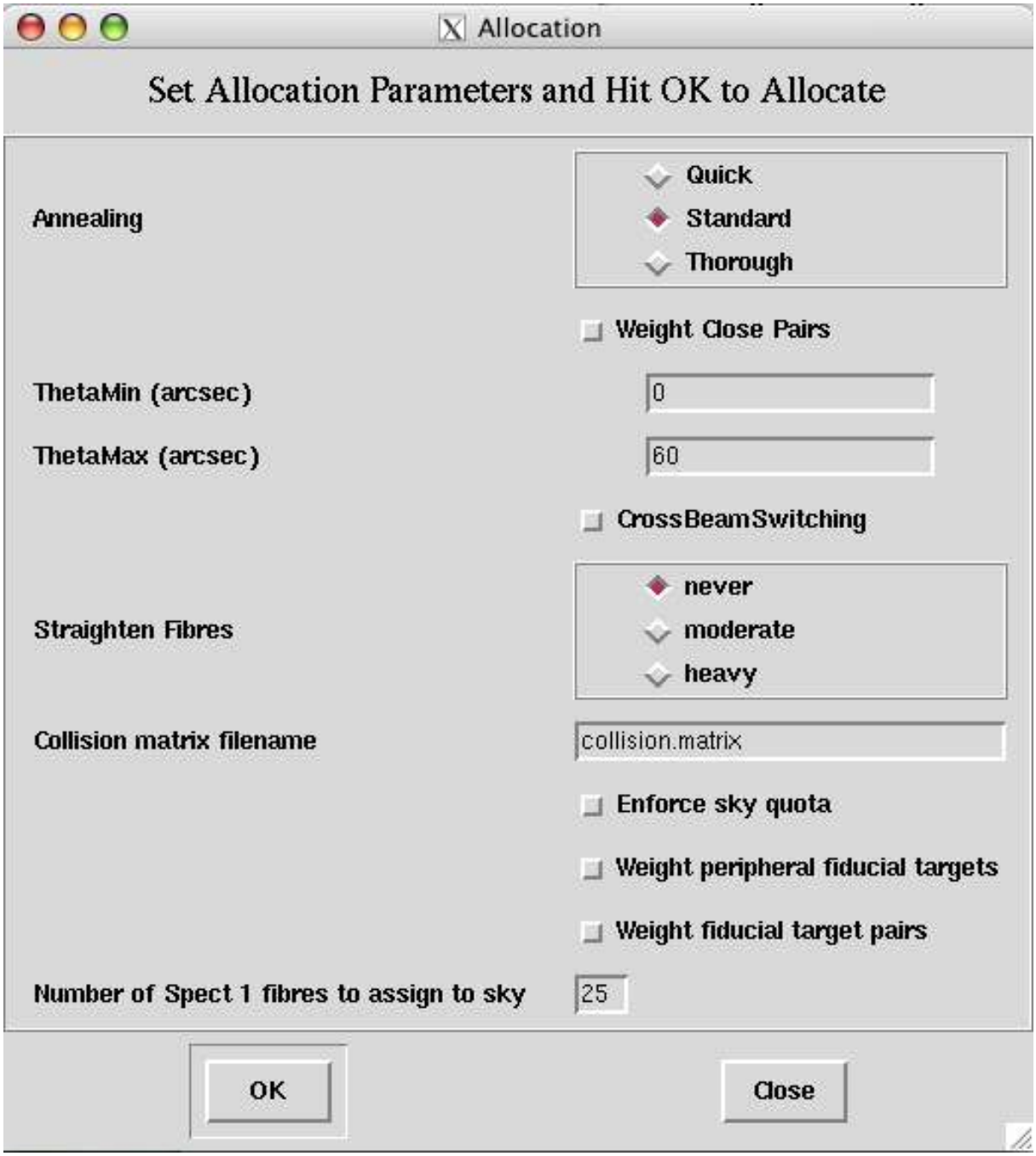

Figure 23 The simulated annealing allocation dialogue

The annealing allocation options are explained in section 7.8.1.2.

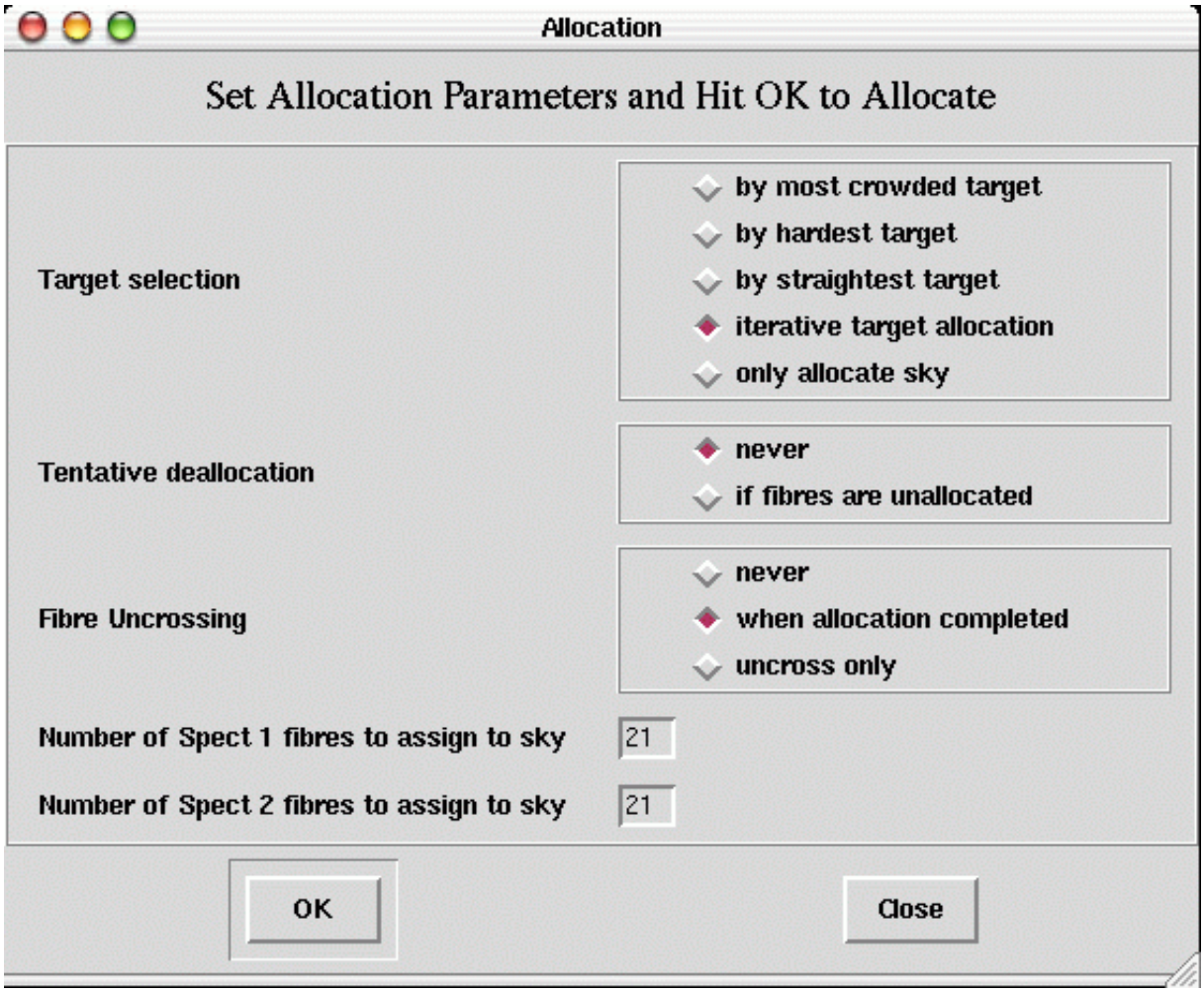

Figure 24 The traditional algorithm allocation dialogue

If you accept the default options and click the OK button, the allocation process will begin. A progress box will be displayed giving some indication of what is going on, and eventually the allocation will be complete. As fibres are allocated, they are drawn in their new positions on the mimic display, and the final result will look something like this:

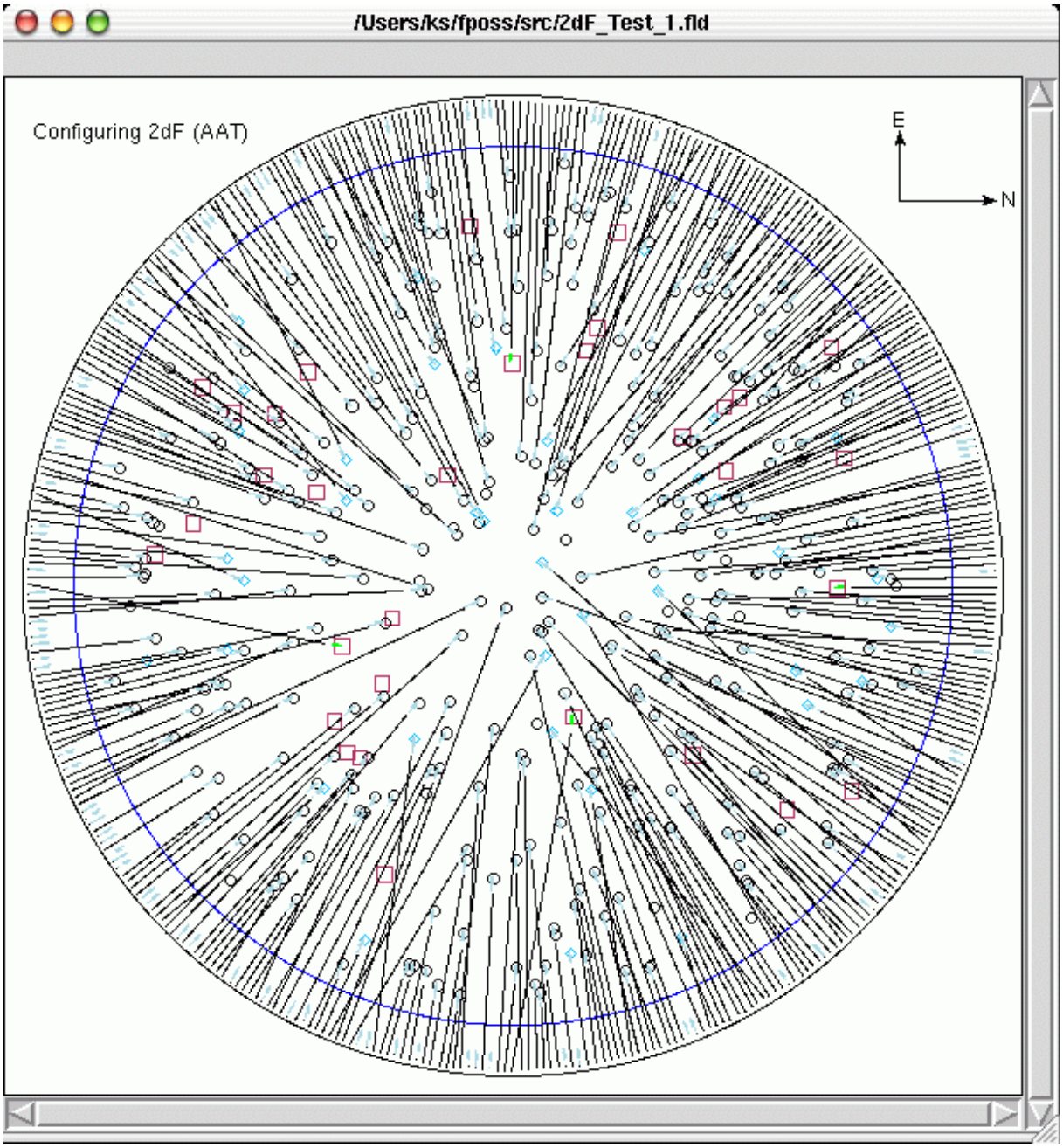

Figure 25 Allocation completed

And that's it. One field allocated. Now all you have to do is save it, and that's the next step in the basic sequence.

10.6 Saving the allocation

Click on 'Save as SDS' in the basic sequence window, and you get a standard file save dialogue. The file name is generated automatically based on the input file name, but you can change it if you want to.

Click on the 'save' button, and the file will be written.

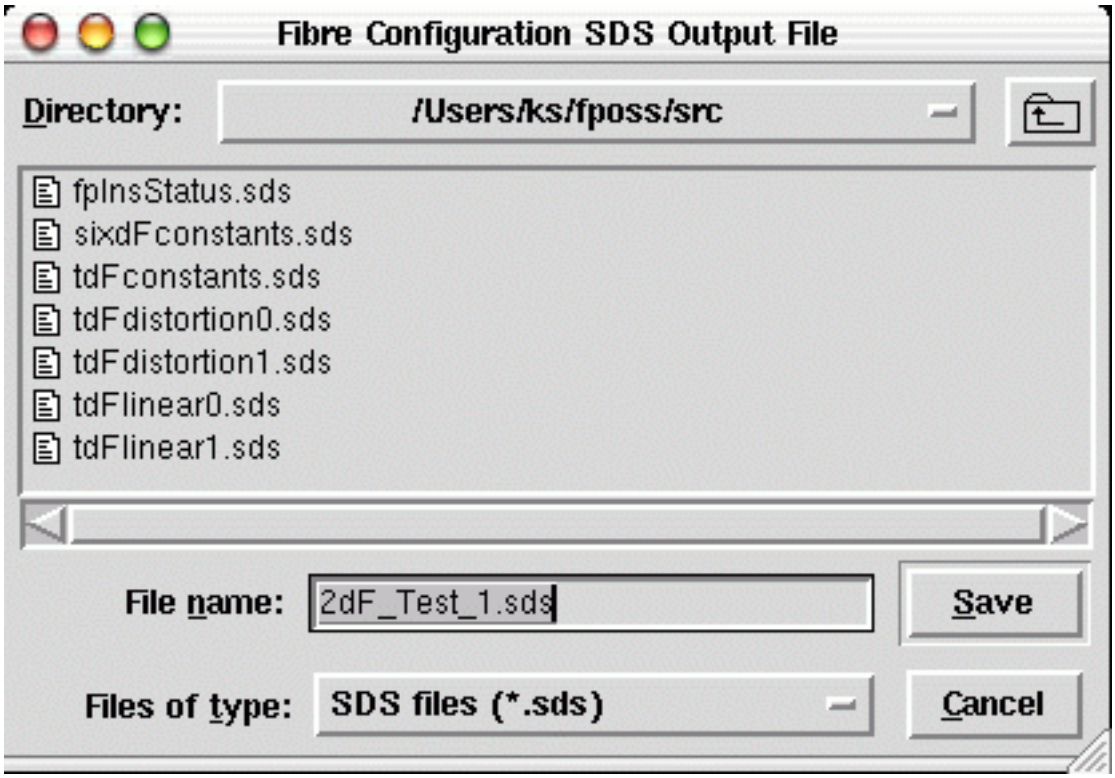

Figure 26 SDS file save dialogue

And that has completed a basic run through CONFIGURE. The basic sequence window should now look roughly as follows:

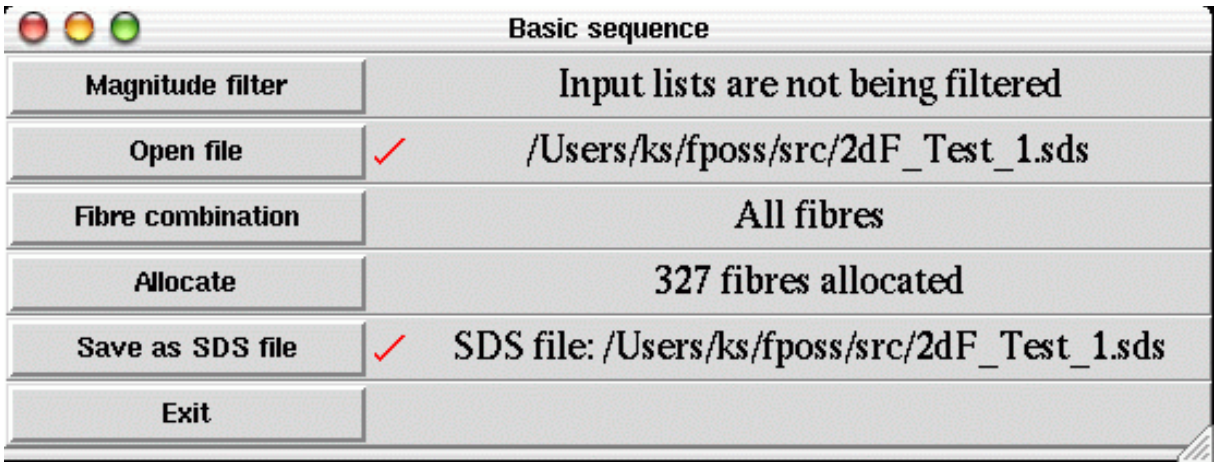

Figure 27 Basic sequence completed

Now you can exit the program using the 'Exit' button, or you can go back to the start and perform a new configuration with a new input file.

10.7 Things not in the basic sequence

There are a couple of things you may want to do as a matter of course when you run CONFIGURE, but which are not included in the basic sequence. One is to set the wavelength

to be used, and the other is to check the range of hour angle for which the configuration is valid.

10.7.1 Changing the central wavelength

The program needs to know a wavelength to use when calculating the positions of the targets on the field plate. If the wrong wavelength is used, then the dispersed images at significant hour angles will result in the fibres getting the wrong portion of the light from the object. To set the wavelength, we need to use one of the menus in the control panel.

Bring the control panel to the front, select the 'Commands' menu and select the 'Set wavelength…' item in the commands menu. A small dialogue appears:

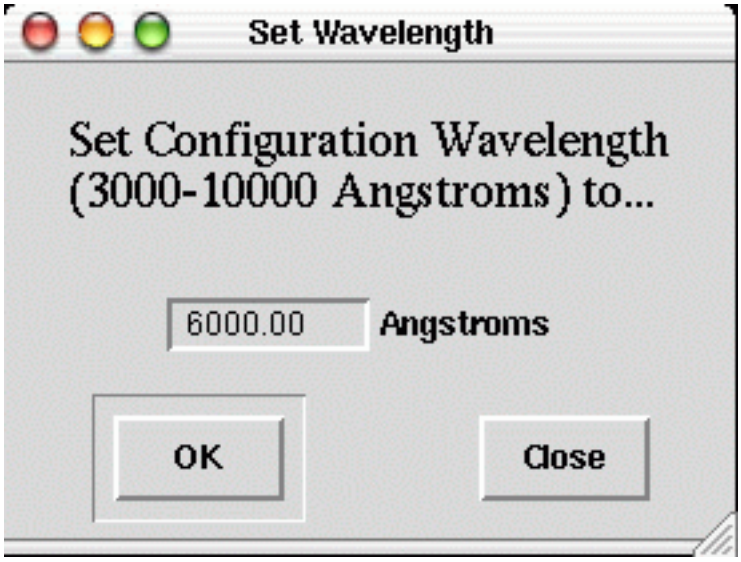

Figure 28 Set wavelength dialogue

You can use this to set the configuration wavelength to the main wavelength of interest for your observations. Note that the guide star positions are calculated on the basis of a different wavelength based on the known characteristics of the guide fibres and their filters. The 'Set wavelength…' dialogue does not affect this guide star wavelength. Note that the units used are Angstroms.

10.7.2 Checking Allocation Validity

The allocation process results in a fibre configuration which is valid at a single time. However, small changes in the relative positions of objects as a result of refraction and other effects could make this configuration invalid at other times and different telescope positions. It is possible to change the Hour Angle using the **Set HA…** option in the **Commands** menu, and then check the validity of the allocation using **Check Allocation**, also in the **Commands** menu.

When CONFIGURE creates configurations, it does so by default using a set of tolerances for such things as button clearances that are more restrictive than those actually used by the

positioner. These have been chosen so that in all cases tested, a configuration was valid (ie would not be rejected by the positioner) over more than a +/- 4 hour range in Hour angle. So unless you intend to observe at truly extreme hour angles, you do not normally need to make this check.

The **Check over Range of HA…** option in the Commands menu performs a check that a fibre configuration remains valid over a range of dates and telescope hour angles. The check should run through with Allocation OK reported in the message region for each position tested. Occasionally one or two fibres or buttons that are OK at the zenith will cause collisions at large hour angles. The simplest procedure is to manually reassign these as extra sky fibres, although it is usually possible to manually adjust the configuration to preserve the target allocation while removing the collisions. An option in the **Check over Range of HA…** dialogue can be used to get CONFIGURE to attempt this reallocation automatically.

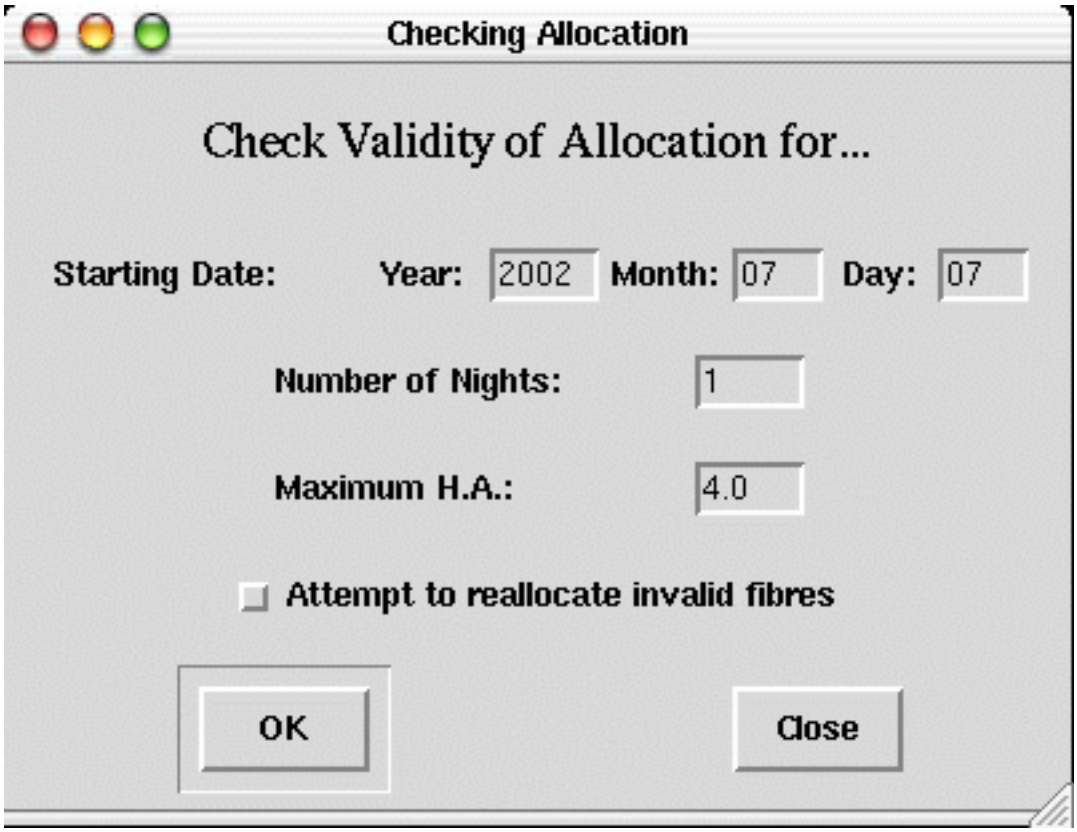

Figure 29 HA validity check dialogue

Naturally, the configuration produced by the allocation sequence just worked through passes this default check. To illustrate a failure a configuration was generated using the actual positioner tolerances rather than the larger tolerances normally used by CONFIGURE. Now there is one rogue fibre that is positioned rather close to a button and at extreme hour angle values moves just close enough to be counted as a collision. If you run the validity test you get:

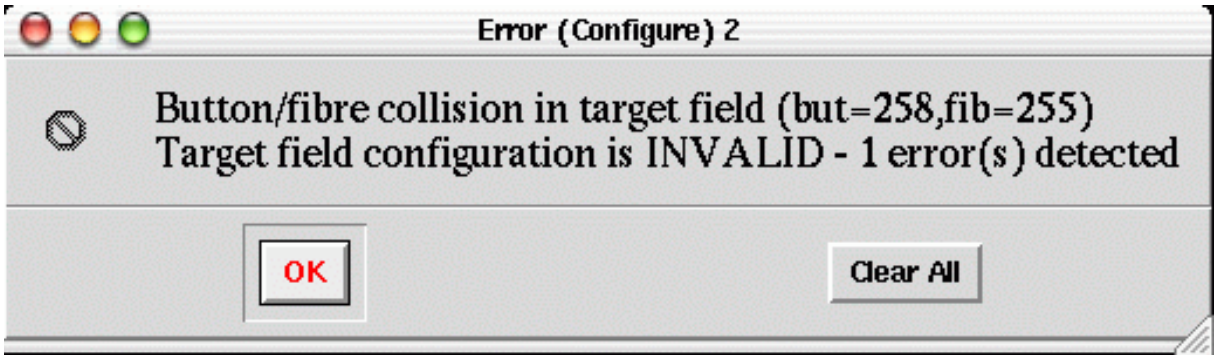
Error (Configure) 2
Button/fibre collision in target field (but=258,fib=255)
Target field configuration is INVALID - 1 error(s) detected
OK
Clear All

Figure 30 Hour angle test fails

By running the cursor over the fibres, you can easily pick up fibres 258 and 255, and you can see that the button on fibre 258 is indeed allocated rather closely to fibre 255. The easiest thing to do is click on fibre 258 then select the 'Deallocate fibre' command from the commands menu. If you run the test with the 'attempt to reallocate invalid fibres' button checked this has the same effect.

11 Appendix B – Bug reporting

No program is perfect, and you may find bugs in CONFIGURE. If you do, please report them to Chris Ramage, at AAO (cr@aaocbn.aao.gov.au). Do, please, include as much detail as possible. Bear in mind that most aspects of CONFIGURE have been tested and found to work on the test fields and operations tried on them. If you have hit a bug, you have probably got something unusual in your input data or in the sequence of operations you attempted. (It may not seem unusual to you, but if it induces a problem then it probably is something that has not been attempted during testing at AAO.) Generally any bug that can be reproduced can be fixed reasonably easily, so the important thing is to include as much detail as is needed to reproduce the bug. In many cases, this means supplying the input .fld file in question, and a description of just what sequence of operations caused the problem to show.

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